CONSENSUS REPORT OF THE TASK FORCE ON EARTHQUAKE PREDICTION CITY OF LOS ANGELES

Earthquake prediction

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Rachel Gulliver Dunne, Chairman

Presented to Mayor Tom Bradley
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Executive Summary

PRINCIPAL RECOMMENDATIONS

o The City should prepare an Earthquake Prediction Response Plan and establish the appropriate coordination and organizational functions to enable a prompt and effective response to any prediction of an earthquake within the region. The plan should provide criteria and contingency plans for a wide range of potential responses geared to the specific time, location, magnitude and probability (or confidence level) of the prediction. This Task Force report provides numerous suggestions and recommendations for incorporation in the Response Plan.

o Ongoing and proposed programs of earthquake safety should be designed for appropriate augmentation or acceleration in the event of a significant earthquake prediction.

o A new emphasis should be placed on public information for earthquake preparedness: families, individuals and neighborhoods will need to be self-sufficient for days and even weeks following a major earthquake, and special programs and materials should be prepared to encourage and assist in this preparation, which should be intensified following a significant earthquake prediction. Specialized programs and materials on earthquake preparedness should address the particular needs of children, the handicapped and the elderly.

o State and Federal actions should be sought on several important issues:

a. Enabling Federal disaster assistance to become available following the prediction of a major earthquake and in preparation for the anticipated disaster.

b. Provision of reliable earthquake insurance, either as a system of Federal earthquake insurance or as part of a Federal system of natural disaster insurance.

c. Clarification of the legal authority and liability of the City for responsible actions taken in response to an earthquake prediction.

o The Earthquake Prediction Task Force should be reconvened by the Mayor in two years (October, 1980) to review the progress in implementing its recommendations and to update its findings based on any changes in prediction technology, legislative action, available programs or public concern.

SUMMARY OF FINDINGS

Although a reliable system of scientific earthquake prediction may not be available for a decade or more, a number of predictions are likely to be made during development of the science, and resulting public concerns and business reactions will necessitate responsive action by local government. A substantial savings in lives and reduction of property damage could be realized with a well-coordinated prediction response.

The scientific validity of predictions will be evaluated by the California Earthquake Prediction Evaluation Council (CEPEC) or its Federal counterpart, NEPEC, and a general earthquake warning will be issued by State or Federal officials if the prediction is verified. The City will need a capability to assess the local significance of the predicted earthquake and to issue local warnings as appropriate.

If an Earthquake Prediction Response Plan were developed before the first prediction is confirmed, the City could make maximum use of the available lead time when a warning is announced, and the advanced planning would allow a rational and timely selection of the components of response most appropriate to the specific characteristics of the prediction. The City could indicate its preparedness and immediately begin implementation of a carefully structured program.

The City should also be prepared to implement a beneficial response to an unconfirmed, pseudo-scientific or low probability prediction which might generate widespread public concern. The City should avoid reinforcing an unconfirmed prediction, but could respond to public concern by providing information and assistance that will help the public become better prepared for any earthquake.

Earthquake Prediction Response Plan

The Earthquake Prediction Response Plan will need to establish a structure for 1) evaluating the local significance of any specific prediction, 2) determining the appropriate response, and 3) expeditiously carrying out the various aspects of chosen response. It should also identify ongoing goals that would make the plan more effective and provide a mechanism for period review and update as new programs, options and legal authority become available.

An Earthquake Prediction Response Plan should contain the flexibility to adjust to predictions of varying magnitudes, probabilities and lead times.

In planning for short, intermediate and long lead times, the number of days available will determine how much can be accomplished. For example, if an earthquake were predicted in a few days, emergency services could be readied, previously identified hazardous buildings could be evacuated, and nuclear reactors and petroleum pipelines could be shut down. With a one-month lead time, buildings could be inspected and hazards identified; contents could be braced; hospital patients could be shifted; reservoir and dam levels could be selectively lowered; and toxic materials could be moved or secured. With a one-year advance notice, buildings could be selectively reinforced and hazardous storage facilities could be replaced. With an advance warning of ten years, building codes and land use regulations could be revised and enforced, and hazardous dams could be replaced or removed from service.

Economic Impact

A credible prediction of a damaging earthquake will have negative repercussions on the economy of the target community, especially if several years lead time is given. The longer the lead time, the more disruption there is likely to be. Problems will range from a decline in sales, property values and tax revenues, to the flight of capital, decreased availability of loans, and increased unemployment. Consturction of new buildings could virtually cease.

Constructive responses to an earthquake warning should include close liaison between the City and the private sector to (1) monitor the local economy, and (2) encourage mutually beneficial, coordinated action, as needed. Unemployment can be combatted by hiring people to work on earthquake preparedness or Public Works projects and by urging an extension of Unemployment Compensation.

If economic impacts become substantial, the federal declaration of a disaster area for the prediction area could provide funds for hazard reduction and perhaps for economic stabilization measures. Funding will be needed to offset the reduction in local tax revenues and to meet the increased demand for City services that would be created by the prediction. The provision of loan guarantees by the Federal or State government would help stabilize the local economy. Various funding sources should be investigated and promoted in advance of a prediction.

There will be a need for reliable insurance for earthquake damage, as no new policies of earthquake insurance will be issued following a credible prediction. Without such insurance, new loans will not be available. To prevent a local disaster from bankrupting individual companies or a single agency, the cost of insurance needs to be spread among a large number of buyers, preferably through a federal program of natural catastrophe insurance.

Social and Psychological Impact

Few extreme reactions are expected from the populace as a whole in response to a significant prediction. Actual panic is not likely, but anxiety and apathy may be expressed by various segments of the population. Recommendations to the public should recognize self-interest as a widespread motivation by providing positive reinforcement with useful information and guidance to groups and individuals in preparation for the earthquake.

Public anxiety can be minimized by providing clear information on the many safe areas in the City and on specific hazardous locations, augmented with information and training on how to make the home, work place and travel routes relatively safe. Volunteer efforts and neighborhood mutual assistance programs should be encouraged. A centralized information center that would also function as a rumor control center would be very helpful in relieving public anxieties.

Problems of credibility will be inherent in the first few predictions. They can be reduced by clearly assessing and explaining the significance of the prediction within the local area and then selecting responses that are realistically geared to the specific prediction. Community leaders and other jurisdictions should be consulted for advice and support in the selection of a prediction response, and seminars for business and community leaders both before and after a prediction will promote wider confidence in the City's preparations.

If relocation or evacuation of residents becomes necessary, most people will prefer to move in with relatives and friends. Host families and sponsoring groups could assist those who have no place to relocate. Shelters will not be readily used for relocation, and are better adapted as information and assistance centers, both before and after the predicted earthquake.

Special attention and preparation will be needed to help maintain the psychological stability of children and families. The special needs of the elderly and the handicapped should be recognized and materials developed to help increase their preparedness. Special arrangements will need to be made to protect and reassure people confined in institutions.

Public Information

Once a prediction is confirmed by the State or Federal evaluation councils, the Mayor should immediately announce the preparations that the City has made and the special measures that can be taken to safeguard the City and lessen adverse repercussions. He could also indicate the effects that the predicted earthquake is likely to have in the City, and the areas and types of buildings that should be relatively safe. Damage maps would help the people visualize the extent of expected destruction, identify safe areas as well as problem areas, and help focus the City's response actions. An Earthquake Preparedness Information Center should be activated to supply a wide variety of answers and information, and to function as a Rumor Control Center. The better understanding people have of the exact nature of the danger, the more calmly they will respond. The more information the City makes accessible to them, the more trusting of City policy and advice they will be. In addition to specific details about the predicted earthquake itself, citizens will probably want to know (1) how to protect themselves and their environment, (2) what to do during and immediately following an earthquake, (3) the kind of assistance available to them in relocation, home safety, and upgrading buildings, and (4) the locations of faults, dams, and other potential hazards.

Safety of Buildings

Building collapse as a result of an earthquake is one of the greatest threats to life and safety, and the warning provided by a specific prediction will enable special precautions to be taken. Unreinforced masonry buildings, erected before 1934, are structures most susceptible to earthquake damage in Los Angeles today. A survey of the estimated 9,000 such buildings in the City is due to be completed in early 1979, and a correction code has already been drafted. A Response Plan could specify priorities and procedures for accelerating code compliance following a prediction, and for relocating occupants of uncorrected buildings. If the code is not adopted before a prediction is issued, there may not be sufficient time for enforcement after the warning comes.

Post-1933 buildings conform to the seismic requirements in effect at the time they were erected, but technological progress and new design concepts are constantly producing new methods of increasing the earthquake resistance of buildings. Based on these advances, certain hazards now can be corrected in post-1933 construction. Structures built between 1934 and 1959 should be evaluated for safe-exiting provisions and mechanical system performance. High-rise buildings built between 1959 and 1973 may need improvements in emergency exit provisions, fire suppression capabilities, utility safety, anchoring of furniture, and occupant safety in case of building "sway." Safety factors should also be checked in post-1973 buildings, although these are theoretically the safest.

Other corrections that could be required in response to a prediction include: the installation of wall anchors in some pre-1973 buildings, repair of defects in wood trusses, tightening of rod bracing systems, strengthening of suspended ceiling systems, evaluation of roof loads, anchoring of rooftop equipment, reanchoring of metal lath ceilings, and the installation of automatic gas shut-off valves. The recently revised elevator code should be approved so that its compliance date of 1980 may be achieved.

Special precautions need to be taken in order for vital structures to remain functional after an earthquake. Vital services in vulnerable buildings should be relocated or the buildings upgraded to meet seismic requirements. Hospitals and Emergency Headquarters should be fully prepared to withstand substantial ground shaking, to have alternate power sources, emergency communication facilities, and ample reserves of need supplies.

Lifelines

An Earthquake Prediction Response Plan should provide special protection to the lifelines of the City. Disruption of transportation, communication, hospital, water, energy, or waste disposal systems will be a source of great inconvenience and possible danger to the citizens, and the loss of lifeline systems will substantially retard the recovery of the City following an earthquake. Lifelines should be upgraded as necessary, alternate facilities planned for when possible, emergency plans for the resotration of service reviewed, and emergency supplies stored.

A Response Plan should consider the supply of water as well as its distribution. Our energy supply should be protected by upgrading buildings which house power equipment and anchoring the equipment in place. Gas shut-off valves should be mapped. Emergency plans for the restoration of services should be reviewed, expanded where necessary, and readied for action.

When the specific details of a predicted earthquake are known, careful analysis of the earthquake resistance of transportation arteries and facilities (roads, bus and rail systems, airports) in the area would indicate which might need to be closed and which should be expected to remain functional. Alternate facilities could then be arranged.

Because of its geologic conditions and the high concentration of hazardous materials in the area, the Los Angeles harbor is extremely vulnerable to earthquake damage. Its problems need thorough study, and preparedness plans should be developed.

Hazardous Facilities

Potential hazards to the City as a result of an earthquake include gas and petroleum pipelines, refineries, and storage tanks which could rupture and cause fires or explosions. Caustic, flammable, toxic, and radioactive materials would also be hazardous if they were to leak into the environment. Although much has been done to ensure seismic safety in newer installations, little has been accomplished in the upgrading of older facilities. Following an earthquake prediction, existing hazard abatement programs should be augmented or accelerated, exposure to hazards reduced, and priorities be directed towards areas most vulnerable to the predicted earthquake.

The failure of dams which are not earthquake resistant could cause widespread destruction and loss of life. Evacuation plans should be completed for all potential inundation areas. Effective procedures need to be established for rapid alerting of the public in the event of actual or potential dam failure.

Emergency Preparedness

An earthquake prediction would enable Emergency Services to gear their respective plans to the specific characteristics (location, time, and magnitude) of an anticipated disaster. Following a prediction, each service should review, update and develop its earthquake response with special attention to maps, lifeline systems, hazard reduction, mutual aid agreements and Emergency Operating Centers. Public information on earthquake preparedness and self-help techniques will be important steps in augmenting the emergency forces, which will be concentrating on the major problem areas and unable to respond to many smaller emergencies immediately following a major earthquake.

Legal Issues

Before an Earthquake Prediction Response Plan is implemented, certain legal issues should be answered. Unresolved questions include: (1) whether there is clear legal authority for the Mayor to initiate action in response to an Earthquake Prediction, (2) whether there is reasonable immunity from liability in taking or failing to take such action, and (3) the potential liability of the City in issuing evacuation orders, preparing damage maps, or taking certain other actions in response to a prediction.

Clarification is needed as to whether a prediction area could be designated a "disaster area" and qualify for appropriate State and Federal disaster assistance in advance of a major earthquake. Assistance would be needed to reduce the economic and social disruption, to supplant a loss of tax revenues, and to take precautions that would save life and property and facilitate recovery efforts. A clear policy statement or legislative action should be sought from State and Federal agencies before the first validation of a prediction.

Coordination

For the most effective implementation of a Response Plan, efficient division of responsibilities among various levels of government needs to be established. An Earthquake Prediction Advisory Committee would be invaluable in advising the Mayor on the local significance of the predicted earthquake and the most appropriate warning and level of response. The Mayor and the Advisory Committee should coordinate their efforts with the Civil Defense and Disaster Board. Many City departments can take an integral part in prediction response, which will range beyond many of the traditional emergency response fields. The Departments of Planning, Building and Safety, Water and Power, Engineering and Public Works will be involved along with the Emergency Services. Recreation and Parks and Library Departments, and Housing, Senior Citizens and Mayor's Offices can participate in the dissemination of information. Liaison with the City Council and other local governments is essential, and a high degree of coordination will be needed among the numerous agencies and jurisdictions involved.

Coordination should also be developed with the private sector -- business and industry, financial institutions, volunteer groups, private utilities, etc. Citizens, too, must know what services they can expect from the City and where their own responsibilities lie.

Funding and Staff

Existing City personnel from various departments should be utilized on a part-time basis for preparation of the Earthquake Prediction Response Plan and related public information programs. In addition, two full-time professionals would be needed for up to two years to organize and coordinate these efforts, and to provide necessary liaison with other agencies, jurisdictions and advisory groups. The Central Earthquake Preparedness Information Center would have a minimal year-round staff, which would be augmented when necessary with trained personnel on emergency loan from various departments.

Researchers in prediction-related fields could act as advisors in these preparations, and should be assisted and encouraged in undertaking research projects of import to the response plan.

Chapter 1

Introduction

The Task Force on Earthquake Prediction was established by Mayor Tom Bradley in November, 1976, "to explore and evaluate the range of possible City responses to an earthquake prediction and provide recommendations for alternative contingency programs that would be adaptable to the specific magnitude, urgency, and confidence level of a given prediction."

The Mayor's action followed increasing scientific and public interest in earthquake prediction, heightened by speculation and intensified research related to the "Palmdale Bulge", a regional uplift of the earth centered on the San Andreas Fault in Southern California. Although a reliable system of earthquake prediction will probably not be available for a decade or more, it is recognized that several predictions are likely to be made during the developmental stages of the science, and that resulting public concerns and business reactions may create a need for responsive action by local government.

Earthquake predictions, like earthquakes, can affect all sectors of the community as well as a wide range of governmental functions. Recognizing the breadth of the topics to be covered, the Task Force conducted much of its work in committees, concentrating its efforts in several major areas, including: emergency preparedness, lifelines, hazardous facilities, safety of buildings, legal aspects, governmental coordination, economic stability, social and psychological impacts, and public information. The principal results of the committees' studies are contained in Chapters 3 through 9 of this report.

Chapter 2

General Background

HISTORIC BACKGROUND

In mid-February, 1976, the U.S. Geological Survey (U.S.G.S.) announced the discovery of a major uplift of the earth covering a large area that is centered approximately on the San Andreas fault in Southern California. Because of its large size and its alignment along a segment of the San Andreas fault that is known to have been "locked" since Southern California's last great earthquake in 1857, scientists expressed concern that the "Palmdale Bulge" or "Southern California Uplift" may foreshadow the next great earthquake in the region. As a result, Federal, State, and University scientists expanded existing programs designed to develop earthquake prediction capability, intensifying and broadening their monitoring of the earth in this area.

In mid-March, 1976, the U.S. Geological Survey noted the potential significance of the Southern California Uplift, and issued a warning:

"If an earthquake similar to that in 1857 occurred today in the region about 30 miles north of Los Angeles, the probable losses in Orange and Los Angeles Counties alone are estimated as follows:

40,000 buildings would collapse or be seriously damaged.

3,000 to 12,000 people would be killed.

12,000 to 48,000 people would be hospitalized.

$15 to $25 billion in damage would occur.

Failure of one of the larger dams could leave 100,000 homeless, and tens of thousands dead."

The U.S.G.S. further indicated that if data supporting a prediction became available, they would evaluate the evidence and transmit their findings to the Governor.

Following the U.S.G.S. warning, the State Office of Emergency Services announced to key local officials that there was "a renewed sense of urgency in preparing for the large earthquake that someday inevitably will occur in this region."

In April of 1976, James Whitcomb, a professional seismologist, issued a trial prediction in the form of a "hypothesis test" which projected a Magnitude 5.5 to 6.5 earthquake for an area similar to that hit by the 1971 San Fernando earthquake. Although the prediction was not directly supported by the California Earthquake Prediction Evaluation Council (CEPEC), the Council indicated that "the data are sufficiently suggestive of such an increased probability as to warrant further intensive study. . ."

Soon thereafter, the realization that Chinese scientists had successfully predicted a major earthquake in February, 1976, thereby saving tens of thousands of lives, gave scientists in the field of earthquake prediction added impetus and increased expectations of eventually developing successful predictions.

It now seemed quite possible that some of the first American earthquake predictions could come from the highly-monitored Southern California area.

STATUS OF THE SCIENCE OF EARTHQUAKE PREDICTION

The evolving science of earthquake prediction is likely to produce a number of scientific predictions over the next decade. Although based on scientific evidence, they will have varying degrees of precision and reliability, and will receive differing assessments from the scientific community. Even the predicting scientist may assign a relatively low "confidence level" to his or her prediction. These predictions may nevertheless allow some appropriate preparations to be made in anticipation of the possible earthquake, with potential savings in life and property. The early predictions will undoubtedly elicit a great deal of public interest and concern.

The following discussion, provided by a seismologist member of the Task Force, offers some additional insights on the prospects for earthquake prediction:

"Most seismologists are reasonably confident that someday we will be able to predict earthquakes with a significant degree of reliability. We have not yet achieved this goal. In fact, the degree of optimism today is somewhat less than it was two or three years ago. At that time, it appeared that seismic velocity changes in the earth's crust preceded earthquakes in a systematic and measurable way. This phenomenon has subsequently been shown to be less dramatic and universal than was originally thought. Nevertheless, clear physical precursors of various types do precede many earthquakes, and some of these promonitory signals have been utilized for several

successful predictions in various parts of the world. American seismologists who recently visited China agree that the Chinese were indeed successful in predicting the major 1975 Haicheng earthquake 5½ hours before the event, thereby saving many lives. Earlier, less precise warnings had identified the area as one of special concern over a period of several years. To date, however, the number of false alarms and failures far exceeds the number of accurate predictions -- in China as well as the rest of the world.

"In this country, most seismologists would probably agree that it will be at least ten years before we have the capability to predict earthquakes precisely and consistently. Successful predictions most likely will be contingent upon our gaining a much better physical understanding than we now have of the earthquake-rupture process at depth in the earth's crust. Such is the purpose behind our very widespread current studies of the Southern California uplift (the so-called "Palmdale Bulge"), as well as intensive studies of the numerous small earthquakes that occur every day in the Southern California region.

"The period during which we are developing an earthquake prediction capability will be a difficult one because we will almost inevitably experience some significant failures and false alarms; this is the very nature of the application of the scientific method. Maintaining public support for the continuing research effort during the development period will be a major challenge. Initial predictions may be of such low confidence levels that it will be difficult to recommend how public agencies should respond, if at all. Nevertheless, it is realistic to envisage that we will eventually achieve a capability of routine, high-confidence-level predictions with time-windows narrow enough (e.g., within a few hours or days) to allow meaningful responses of emergency forces.

"Even if scientists are unable to predict earthquakes routinely with great accuracy for a decade or more, it is important to recognize that some scattered predictions will be forthcoming during the intervening years. Although some of the early predictions may be generalized, controversial, and difficult to respond to, public agencies cannot afford to wait for a fully developed prediction capability before formulating response plans. Now is the time to worry about developing programs for constructive response. Clearly, the City must be prepared with a range of responses suitable to a wide variety of predictions."

COMPONENTS OF A PREDICTION

Although scientists have been making general earthquake predictions for many years (e.g., "a major earthquake will occur in Southern California within the next 100 years"), the prospect of more specific and reliable predictions has led to the formulation of standards for the requisite information that should be elucidated in any prediction. The four major components are:

Magnitude (Richter magnitude at the earthquake focus)

Location (expected vicinity of the epicenter)

Time (preferably including the lead time before the event will occur and the time window within which it could occur)

Probability (that the event will occur as predicted. Until there is an adequate statistical basis for determining probability, scientists will probably prefer to indicate a confidence level instead.)

Some scientists would also like to see a fifth prediction component -- predicted ground motion, including peak acceleration. This additional component would facilitate more accurate estimates of earthquake intensity.

ISSUING AND EVALUATING A PREDICTION

WHO WILL RELEASE PREDICTIONS?

An earthquake prediction can come from scientists at public or private universities, from State or Federal scientists, non-affiliated scientists, or individuals using non-scientific or semi-scientific prediction techniques. Because of this variety of sources as well as the open approach to scientific research that exists in western societies, a prediction will become public knowledge and be broadcast by the news media very quickly. Experience has demonstrated that a possible prediction is likely to be uncovered by the press unless it is announced to the public promptly. Initially, public response to a prediction will depend on the credence and publicity given to that prediction by the news media.

EVALUATION OF A PREDICTION

Both the State and Federal governments have set up mechanisms for evaluating earthquake predictions. Scientific predictions of damaging earthquakes affecting the State of California are reviewed by the California Earthquake Prediction Evaluation Council (CEPEC), a panel of recognized earth scientists. The Council will evaluate the scientific basis for the prediction and determine

whether it merits verification. CEPEC reports its conclusions to the Governor and the State Office of Emergency Services. It is generally the policy of the Council to make its deliberations open to the press and public, and to announce its findings immediately. If a prediction of a damaging earthquake is validated by the CEPEC, either the Governor or the Office of Emergency Services will most likely issue an official warning, with some initial recommendations on measures that could or should be taken at State and local levels to prepare for the predicted earthquake.

If a prediction arises within the Federal scientific establishment, it will be submitted to a review committee which advises the U.S. Geological Survey*. Federal predictions may or may not become public knowledge before the federal committee has completed its evaluation. The U.S.G.S., which issues all federal warnings of impending geologic hazards, will probably submit any warning of a California earthquake to the Governor and perhaps to local leaders such as the Mayor. Whether the federal warning is announced by the U.S.G.S. or by the State, the warning is likely to become public almost immediately. CEPEC may then wish to provide an additional review of the Federal prediction of a California earthquake.

POSSIBLE PREDICTION SCENARIOS

Predictions during the next decade could involve a wide range of variables with respect to credibility of source, lead time, specificity of detail, and confidence level assigned to it. Several possible scenarios are described below. They raise some provocative questions relating to the potential response of the City, and contingency plans should consider appropriate responses to the following possibilities:

- The sequence of events most commonly envisioned by earth scientists deals with a progressive refining of prediction details over several years. The first stage would be an announcement that the area is being designated for intensive study of possible earthquake precursors. Such an announcement could be based on indications of a possible earthquake but inadequate data for any specific predictions. (It should be noted that the area of the Southern California Uplift is already in this pre-prediction stage.) The next stage could be a general prediction of a possible earthquake several years hence (perhaps two to five years in the future), with a relatively large time-window (several months to a few years) and only a general indication of the location and magnitude of the earthquake. A high probability or confidence level is not likely to be assigned to the prediction at this stage. Over the subsequent years scientists would attempt to refine the prediction by collecting additional data relating to the anticipated mangitude, time window or location of the earthquake, and perhaps by raising the confidence level. It is also possible that the prediction could be rescinded if new data is contradictory or fails to follow the anticipated pattern. As a final stage, a short-term prediction that an earthquake is expected within a few hours to several days might be issued. At this point the confidence level assigned to the prediction may or may not be increased, although in an ideal situation the probability assigned would be 70 percent or better. At each stage of refinement the predictions would presumably be evaluated by CEPEC. How does the City respond to a changing prediction, or even to the cancellation of a prediction?

- A valid scientific prediction is affirmed by CEPEC. Scientists assign it a low confidence level (e.g., 25%) that stays low throughout the prediction period. How do we respond to a low-confidence-level prediction of an earthquake -- one that probably will not happen?

- A valid scientific prediction of a relatively high confidence level remains very ill-defined as to specific time and place (e.g., somewhere in Southern California during the next year). How can a specific locality such as Los Angeles respond to such a prediction, if at all?

- A prediction is discredited by CEPEC, but is strongly defended by a scientist or a group of scientists with sufficient credentials to be considered legitimate by the public and news media. How do we react to strongly split opinion among the scientists, even if the weight of opinion is predominantly on one side? (A strongly split vote on CEPEC itself is certainly not out of the question).

- A short-term sequence of allegedly premonitory events, such as a 24-hour burst of magnitude 5 earthquakes on the San Andreas fault at Palmdale, happens so rapidly that no scientific consensus is possible. Nevertheless, several scientists publicly express concern about the possiblity of an imminent earthquake. Should the City be in a position to react even in the absence of a scientific consensus or a full report from CEPEC?

- A prediction that is unanimously discredited by the scientific community gains wide acceptance via the news media and rumors. Should the City respond at all to this kind of situation? Should the scientific community react more aggressively to discredit allegedly "unscientific" predictions? Can we somehow avoid the syndrome of "the underdog vs. the (scientific) establishment?"

* Present plans call for the formation of a National Earthquake Prediction Evaluation Council (NEPEC) to be composed of university, independent, and U.S.G.S. scientists. Preliminary coordination procedures for the state and federal councils have already been worked out.

POTENTIAL EFFECTS OF AN EARTHQUAKE PREDICTION

Most Californians are familiar with the types of damage and disruption an actual earthquake can produce. Only recently has it been recognized that the credible prediction of an earthquake could itself produce widespread disruption whether the earthquake occurs or not.

Studies released over the past few years indicate that although an earthquake prediction would provide the opportunity for significant saving of life and property, a series of social and economic changes -- to the potential detriment of the stability of the area -- could also result.

A major NSF-sponsored study on the Socioeconomic Impact of Earthquake Prediction* used extensive interviews with seismologists and representatives of news media, government, business firms and the general public to determine their reactions to a hypothetical earthquake prediction.

The hypothetical prediction had four phases spanning three years time. The phases were similar to our first scenario (preceeding section), with increasing specificity and confidence levels at each phase: 1) In the first phase the announcement that the local area has been designated for intensive earthquake study is followed by independent statements from two reputable scientists that the data suggests a 25 percent probability of a damaging earthquake in approximately three years. 2) A year later the U.S. Geological Survey releases an official prediction with a 50 percent probability of a Magnitude 7 (or greater) earthquake to occur two years from that time. 3) About six months from the target date the prediction is refined to an 80 percent probability, with a specific one-month time window and a magnitude of 7.1 to 7.4. 4) About a month before the target date the prediction is further refined for a 7.3 magnitude and a one-week time window within which the earthquake is expected to occur.

This prediction scenario was then augmented in succession by incorporating the results of interviews, first with the media and government representatives, and then with business leaders and the general public. The results of the study provide significant insights on the type of reactions a longer-term prediction of a highly damaging earthquake could produce, although the magnitude and extent of the reactions may not be as great in some respects. The study documented major reactions to the hypothetical prediction in the following activities:

- Construction: Most new construction in the "target" area has ceased eleven months after the first U.S.G.S. announcement. Immediately after the first official prediction, planned construction within 25 miles of the predicted epicenter has not begun, although existing work continues.

- Lending: Lending institutions operating in the "target" area reduce by as much as 80 percent the number of loans they are making in the area after the first prediction. New loans still being made require higher down payments, fewer people can qualify for loans, and property becomes difficult to sell.

- Population Movement: Eleven months after the first U.S.G.S. announcement, population growth in the "target" area has slowed and far fewer new businesses are opening now than a year ago. One year after the first official prediction, many people are considering moving out of the area permanently; within three months nearly eight percent have done so. Within the year before the target date more area residents begin to make plans to leave at least temporarily, but about 50 percent still plan to stay. At this time, a few national business firms move permanently. Immediately before the expected earthquake, nearly 60 percent of the population have left the area (ten percent have left permanently). One-fourth of the temporary evacuees have moved into shelters set up by the Red Cross; the others have left the area for vacation trips or to stay with relatives or friends.

- Taxes: Seven months after the official prediction, there is a slight decrease in city sales tax revenues and city officials begin to plan for the necessary cuts in services. Approximately one year before the target date, more than half the property owners in the area request lower assessed valuations of their properties. Property taxes paid to local governments fall off slightly, with a few property owners withholding all payments in protest against the decrease in city services and others paying only part of their assessments. There is only a very slight drop in mortgage payments, however. Three months before the expected earthquake, local sales and property tax revenues have declined appreciably.

- Employment: Unemployment in the building trades approaches 80 percent four months after the official prediction. General unemployment gradually rises as the decrease in business activity forces many firms to lay off employees.

- Retail Sales: One year after the first prediction, evidence indicates that one-fourth of all families are postponing large purchases. During the year before the expected earthquake, retail sales continue to drop as more people in the area decide to delay major purchases; only about 40 percent of the population maintain their usual buying patterns.

* The study was conducted by a research team from the University of Colorado and Colorado State University and headed by Eugene Haas and Dennis Miletti. Interviews were conducted in both Southern and Northern California and the results were released in December, 1976.

- Business Closures: Nine months before the expected earthquake, one-fourth of the small businesses in the area have either declared bankruptcy or sold out due to the economic pressures. Many other businesses close down completely in the two weeks preceding the predicted earthquake.

It should be pointed out that the hypothetical prediction scenario represents both a high probability (80%) prediction and a long lead time for the various reactions to set in. (In another scenario, with a shorter lead time, the same research team detected very few adverse reactions.) In spite of ingenious efforts to simulate a real-life decision-making situation, the people interviewed were hypothesizing about a condition which was markedly different from anything in their past experience. Business leaders based their decisions on factual estimates, such as number of people leaving the area. Error in these approximations could have produced unrealistic decisions. Furthermore, the researchers emphasize that their findings will come true only if there is no effective program to forstall and counteract adverse developments. When their study was conducted, neither local nor state governments were prepared to monitor the various reactions or to implement appropriate measures that could have offset some of the more extreme responses.

Despite the dire consequences of the prediction as detailed above, the researchers felt strongly that, in the long run, predictions of this type will be of great benefit to society. A prediction could be the "dominant driving force" in increasing the scope, intensity and specificity of efforts related to preparedness for the earthquake, as well as in planning for relief, restoration, and reconstruction following the earthquake. They also noted that the social and economic reactions documented in the study had the beneficial effect of reducing the degree to which life and property would be endangered by the earthquake.

Chapter 3

Social and Psychological Impact

BACKGROUND

The major consequences of an earthquake prediction will be determined by the individual and collective reactions of the affected community. Any governmental action will be influenced, in large part, by impressions of what the public response will be. Therefore, City officials should know what psychological responses to expect, what the social needs of the community will be, and what actions would effectively serve the evolving needs of the community during the prediction period.

A wide range of reactions to earthquake prediction is anticipated. Responses may run the gamut of possibilities and will vary according to age group, cultural heritage, and the quality of relationship an individual has with his family and society.

Local receptivity to the idea of a future damaging earthquake may be influenced by a widespread cultural recognition in California that "the big one" can occur at any time and may even be overdue. Few extreme reactions are expected from the populace as a whole, although indifference or grave concern may be expressed by some individuals or some segments of the population. Panic, in terms of an immediate reaction which stimulates drastic decisions in the short range, is unlikely, despite the tendency for cinematic dramatizations to exploit this theme. Widespread apathy, a total lack of reaction, is also unlikely, for underlying anxiety gradually will arouse most citizens to some form of action. Many people will, however, demonstrate a "normalcy bias" by choosing to follow normal, familiar routines in response to anxieties created by the prediction. This may manifest itself as a predisposition to hope, a tendency to normalize events, postpone action, or anticipate survival. Many people will assume they have a better concept of the truth than they actually do. The "normalcy bias" will tend to produce inaction, especially if a more appropriate response to the prediction is unclear or appears to be difficult.

Much of the individual response to a prediction will be predicated on self-interest, the individual's perception of rational response, and the pursuit of individual priorities, either for preservation or indulgence. Self-interest will often be an initial and sometimes a continuing motivation. This is not necessarily a negative prospect. In fact, local officials may find it advantageous to increase their understanding of self-interest, improve its quality, and cooperate with those self-interest reactions that enhance stability in the community. These reactions may occur in stages, progressing through an increasingly broader circle of self-interest:

1. Self-preservation.
2. Family, loved ones, relatives, close friends.
3. Economic survival, livelihood, work, income.
4. Material object preservation.
5. Immediate neighborhood.
6. Social and organization contacts.

Unless they are carefully guided, reactions in the larger circles of contact, particularly in the realm of economic survival, could result in economic costs and social disruption greater than similar costs of a real earthquake. (See Chapter 4.) Unlike a disaster, a long or medium range earthquake prediction does not lend itself to spontaneity. The advance warning allows time for self-interest to enter into contemplation, hedging, or planning, particularly in decisions relating to finances, family, income-employment and material objects. In such situations, individuals with a vested interest in the community (leaders, business people, home owners, etc.) may be important stabilizing influences.

The announcement of a prediction will not necessarily incline the public to give up personal preferences for action in compliance with governmental programs. If the populace believes they have legitimate reasons for noncompliance, government orders will be ineffectual. Particularly if they believe the consequences of a prediction are disadvantageous, potential victims of a predicted earthquake are likely to act on their own, perhaps contrary to the plans of governmental agencies, without waiting for advice or offers of assistance.

ISSUES AND RECOMMENDATIONS

ISSUE #1: Announcing the Prediction Response

The Mayor's Office is not likely to be the first to announce a prediction, or to be the controlling center for initial information. Follow-up announcements by the Mayor's Office have the handicap of competing with the more spectacular primary stories. Moreover, the office will have to contend with a public and media reaction of "already knowing about it."

Recommendation: The Mayor's Office can elicit the confidence of the people by demonstrating well-informed leadership and promptly announcing a local response plan following the verification

of a prediction by the California Earthquake Prediction Evaluation Council (CEPEC). Progress towards rational acceptance and productive response is more likely to occur if the Mayor's Office specifically supports the prediction and initiates productive action to protect and assist the community.

ISSUE #2: Responding to a Prediction Before CEPEC Reaches a Decision

Past experience indicates that predictions are likely to be revealed by the news media before they can be submitted to CEPEC for evaluation, and that there will be an additional lag time before CEPEC can complete its evaluation.

Recommendation: When a prediction is made public before CEPEC has issued its findings, the Mayor and City agencies should be sufficiently prepared that the Mayor can announce that the City is ready to take appropriate actions once any prediction is validated.

ISSUE #3: Responding to an Unconfirmed Prediction

It is possible that CEPEC will fail to support a scientific prediction that continues to be defended by one or more scientists with widely accepted expertise. Disagreement within the scientific community about the validity of a prediction will heighten public skeptism and anxiety.

Recommendation #1: If local government is faced with a highly publicized prediction without consensus or with a rejection from the scientific community or CEPEC, a low-level response program could be announced. Regardless of the validity of a prediction, this type of plan would allow concerned citizens and organizations to take positive actions that would allay their fears and better prepare them to withstand any future earthquake.

Recommendation #2: The low-level response could also be augmented with limited implementation or acceleration of seismic safety programs by the City, if the Mayor's advisors determine that there could be merit to the prediction.

ISSUE #4: Responding to Non-Scientific Predictions

Popular concern and acceptance of a prediction will not necessarily increase in direct proportion to the scientific validity of the prediction. Questions about the credibility of a scientific prediction may increase public interest in non-scientific predictions as well as scientific ones. A recent study of non-scientific earthquake predictions conducted by the U.S. Geological Survey concluded that their general validity is less than if predictions were made by random chance.

Recommendation #1: Scientists will make clear which predictions they consider valid and which invalid, but this is not the appropriate time for the City to launch a campaign to wean people away from nonscientific views.

Recommendation #2: When nonscientific predictions are widely reported in the news media and public concern is aroused, the City should not reinforce the prediction itself, but can provide specific information on earthquake preparedness that would allow concerned individuals to become better prepared for any earthquake.

ISSUE #5: Achieving Credibility

Until earthquake prediction and prediction response have become accepted procedures comparable to flash flood watches and hurricane warnings, public skepticism of the process may lead to a substantial reduction in the public benefit that would otherwise be derived from a prediction.

Recommendation #1: The City should not try to magnify the significance of a prediction, but should attempt to clearly assess its significance to the local area and carefully select a slate of response actions that are realistically geared to the magnitude, location, timing, and probability of the predicted event. The significance of the prediction's parameters should be clearly and repeatedly explained to the public.

Recommendation #2: In evaluating the appropriate prediction response, seek the advice and support of community leaders, including those from scientific, religious and social services communities. They could also be invited to participate in the announcement of the City's response plans for that prediction.

Recommendation #3: Work for the support and concurrence of the County Emergency Preparedness Commission, which is comprised of representatives of the City, the County, and other local jurisdictions.

Recommendation #4: As an aid in building confidence, before any prediction is issued arrange a series of meetings with opinion leaders to explore their views on the responsibility of the Mayor's Office in responding to a prediction. (See Chapter 8, Issue #4.) Discuss various kinds and levels of action that may be taken. Distinguish between appropriate responses to a credible prediction and a low-probability or "pseudo" prediction. When a specific prediction response is to be announced, seek the cooperation of these leaders again. This group should include representatives of:

News media
Major political organizations
Ethnically segregated communities
Seismologists and geologists
Religious leaders
Leading businesses, or business associations
Unions
Civic associations
Professional associations

To gain further insights, request a resume of what each organization would be likely to do in the event of an earthquake prediction.

Recommendation #5: Major economic decision makers could be a crucial group with whom to seek cooperation. Their perception of prediction and the impact of their decisions could have an effect on community survival. If prediction warnings have been issued from quarters other than the Mayor's Office, the economic community is likely to proceed with their own interpretation and planning. That would remove the initiative from the Mayor's Office and trigger a game of "catch-up" or rectification unless cooperative discussions are held with this community before a warning is issued. The City should sponsor seminars with business community leaders following a prediction. In addition to the inherent advantage of gaining credibility for a prediction, these discussions would increase confidence in the City's ability to cope with the impending disaster.

ISSUE #6: Controlling Anxiety

A period during which a prediction and warning are in effect may be more anxiety-producing for some people than disaster itself. The clearer and more certain the sense of where and when one is in danger and where and when one is safe, the less prone people are to attacks of uncontrollable anxiety. Concerted and repeated training in how to be relatively safe in an earthquake is reassuring. Anxiety is more easily subdued if individuals understand what actions can be taken and are able to do something in preparation for the coming earthquake.

Recommendation #1: In advance of any prediction, information should be prepared on procedures for making the home, working environment, and travel routes safe. This information should be as specific as possible.

Recommendation #2: Announcements regarding hazardous buildings should also be accompanied by general information on the types of buildings that are inherently resistant to earthquake damage. For example, the vast majority of one- and two-story wood-frame buildings, such as those widely used for suburban residences, are highly resistant to collapse in an earthquake.

Recommendation #3: A centralized clearing house for information that can relieve and clarify psychological and social anxieties should be prepared for activation when a prediction is announced. (See also Chapter 8, Issue #2.) This has proven to be one of the most useful governmental projects in natural disaster situations.

Recommendation #4: The earthquake information center should also function as a rumor control center as a means of encouraging stability of information and reaction.

Recommendation #5: Once a warning is issued, encourage the development of a program of volunteer activities, perhaps augmented by a neighborhood "warden" network. The network or neighborhood could be used to create a framework for emergency mutual aid following the earthquake, to transmit essential information to many who might otherwise miss it, to identify people whose problems require special attention, and to involve people in neighborhood support groups.

ISSUE #7: Dealing With Denial

Anxiety can produce a denial of the threat in order to remove the cause of worry. A certain amount of denial will be caused by fear of business losses if the prediction and warning are taken seriously. Some populist and minority groups and other population segments may express anti-establishment and anti-scientific attitudes in their suspicion of the motives of scientists and public officials. Most of these responses must be understood more as ambivalence than as outright disbelief.

Recommendation: Scientists and public officials should deal with responses of disbelief by emphasizing the actual nature of the danger rather than engaging in attacks on the disbelievers that can polarize the community.

ISSUE #8: Dissatisfaction With Local Government

Local government, the most conspicuous level of authority for responsibility and complaint, will be the object of intense reactions during the prediction period. Initially, people may be pleased with a job well done and grateful for the foresight provided by a prediction. But a long lead time between prediction and earthquake is certain to stimulate innumerable questions and proposals, some of which may be derogatory if citizens perceive local government action to be inadequate. This questioning and proposing occurs because (1) there is time to develop a critical assessment of government response, and (2) there is widespread belief that individuals alone are not able to resolve the massive problems associated with an earthquake. As a result, residents of the City will expect governmental agencies to provide answers and broad solutions, whether or not the authority, funds, resources, or consensus is available to permit these agencies to satisfy all queries and suggestions.

Recommendation #1: Lines of communication between City Hall and the general public should be kept open during a prediction period, and the City should demonstrate a sincere interest in receiving and responding to information on the developing needs of the public.

Recommendation #2: Viable Public Information and Self-Help programs can increase self-confidence and self-reliance, prodding people to assume greater responsibility for their own welfare.

ISSUE #9: Educating the Public

If a prediction is vague as to exactly where and when a particular earthquake will occur, public reaction from that segment of citizenry with vested interests in the community could become intense. People will demand more precise information on the significance of a prediction and the potential effects of the predicted earthquake, as well as measures that can or will be taken to protect their welfare.

Recommendation #1: In announcing a prediction response, clarify these factors:

-Probablity, likelihood, reliability of prediction.
-Magnitude and intensity.
-Lead time as well as time-frame of earthquake.
-Region of anticipated impact.

Also provide, as soon as practicable:

-Damage maps, showing the projected distribution of light, moderate and heavy damage throughout the City.

Recommendation #2: Present recommendations in terms that reinforce personal self-interest, cooperation, and community interest. These features should be expressed in statements of what the Mayor's Office advises the public to do in the public's best interest.

Recommendation #3: Evolving Education: As interest and awareness of the earthquake prediction topic grows, the level of information and knowledge will change. Interest and knowledge may become more sophisticated. Consequently, the Mayor's Office will want to be prepared with phased educational materials, each increment treating the topic in an increasingly more professional manner. (For further details, see Chapter 8.)

Recommendation #4: Earthquake Side Effects: Utilize the occasion of a prediction to educate the public about secondary effects of an earthquake such as: fresh water contamination, disruption of water supply, leaking gas, uncertainty of sewage lines, broken electrical connections, chemical leakage, etc.

ISSUE #10: Mobilizing Public Action

The competing demands of daily activities, combined with the tendency of many people to avoid anxiety by following normal routines, will tend to limit the extent of productive preparations that would be taken by the public. The potential savings of life and property derived from knowledge of the prediction will thereby be reduced. Special measures may be necessary to motivate the people to take appropriate precautions.

Recommendation #1: When an earthquake warning is announced, the public should be instructed to take actions which will increase general preparedness for any earthquake. Encouraging people to be self-reliant, such instruction will engage them in advance planning. They will begin to act on long-range intentions as a time frame is established by the prediction date. Thus, prediction can be a stimulus for financial planning, correcting interior hazards, and upgrading buildings as time allows.

Recommendation #2: The independent behavior of citizens through customary social structures will relieve some of government's responsibility for recommending courses of action and solutions to the consequences of a prediction. The City should assist and encourage established organizations and informal communities to provide productive solutions and responses in their own areas of influence.

Recommendation #3: Management personnel could promote effective action within their own companies or agencies. They should become familiar with response plans and maintain a state of readiness. The Mayor's Office should make prediction planning material available to them.

Recommendation #4: Research indicates that attempts by governmental agencies at deliberate control of the public in anticipation of predicted natural disasters have not been very successful and can undermine respect for governmental competence and authority. Therefore, it would be wise to stress cooperation with the public in developing self-sufficiency rather than rigid (absolute) control.

ISSUE #11: Providing for Children

The education, preparation, and care of children are important aspects of an earthquake prediction response plan.

Recommendation #1: In advance of an actual prediction, the Mayor's Office should prepare a program and materials suitable for children and parents, in anticipation of a need which is likely to arise. The survival and psychological stability of the family will have a high priority for many people.

Recommendation #2: Elicit the participation of the school district in preparation of the response plan, and encourage special in-school programs to help meet this need.

ISSUE #12: Providing for the Handicapped, Aged, and Institutionalized

Recommendation: The Mayor's Office should consider and have available recommendations and procedures for aiding, coping with, or facilitating those individuals with restricted ability to affect their own welfare. Although the handicapped and aged come readily to mind, there is a pressing need to assist individuals locked in secure institutions. They will be even more entrapped if an actual earthquake occurs.

ISSUE #13: Relocation and Evacuation

Where imminent hazards can be identified, it may be necessary to advise occupants of a building or neighborhood to relocate temporarily for the immediate time window of the predicted earthquake. In certain cases, full evacuation of selected buildings or limited areas might be ordered. Shelters have not been very effective in attracting and holding citizens in anticipation of a predicted disaster. Past experience indicates that most people evacuated at the time of an emergency will prefer to find refuge with relatives or friends whenever possible.

Recommendation #1: The City should assist in finding relocation housing for persons and families displaced from hazardous structures as the result of prediction warnings. For those whose relocation with family and friends is not practical, established organizations and volunteer foster families could "sponsor" displaced families or individuals. Public relocation centers should be used only for very temporary housing of people in transition. The placement of relocated families should attempt to maintain proximity to accustomed work, school and community centers, whenever possible.

Recommendation #2: Additional temporary housing will probably be needed after the earthquake; arrangements should be made before the earthquake occurs.

Recommendation #3: Advance plans should be made for the permanent relocation of as many as 10,000 to 50,000 people who may not be able to return to their former homes following the earthquake.

ISSUE #14: Using Shelters

Past experience indicates that shelters do serve as focal points when they function as information centers or training locations for individuals and groups. Providing a reasonably controlled environment for personal interchange of views about earthquakes and predictions between neighbors, they can increase the sense of neighborhood and community, and stimulate the formulation of locally oriented preparedness programs.

Recommendation: Shelters set up in anticipation of a forthcoming earthquake could operate prior to the earthquake as community information centers and meeting areas, and promote greater preparedness within the community. Local familiarity with the centers would promote their more effective use in an earthquake's aftermath.

ISSUE #15: Studying the Problem

A complete analysis of the psychological and social impacts of earthquake prediction is a complex project. Because of the scope of the topic, the subject deserves further research. An organized research program could be undertaken by, or in cooperation with, university researchers and/or professionals in the field.

Recommendation #1: To facilitate the formulation of public announcements and actions, a three-phase study could be conducted to ascertain the correlation between self-interest responses and community stability goals.

a. Phase 1: Conduct a free-ranging probe of what individuals and organizations are likely to do without any official guidance.

b. Phase 2: Independently ascertain those effects or actions that would be desirable in achieving community stability.

c. Phase 3: Based on an integration of "a" and "b", rephrase public announcements, emphasizing what the individual can do; recommendations can be geared to the self-interest of the individual as well as the stability of the community.

Recommendation #2: Develop a plan using the four variables (probability, magnitude, location, date) and representing the wide variety of circumstances that would characterize a prediction. This system could facilitate planning for different levels of response related to the specific characteristics of the prediction.

Recommendation #3: Simulation: Systems Analysis. Research is needed to develop a simulation exercise which would cover the entire lead time for a series of prediction announcements. This type of drill would be helpful to responsible government people and key representatives of the public. It would accomplish the following:

a. Provide experience and allow for adjustment in a prediction response plan.

b. Revive and enliven an awareness of the ramifications of a prediction that might otherwise be forgotten as government officials cope with more immediate problems while awaiting the disaster.

c. Capture the interaction and dynamic behavior of different components of an earthquake prediction response system.

Recommendation #4: Simulation: Preplan. To improve existing prediction response plans, a study should be conducted to outline a simulation exercise that could be practiced annually in September. Utilize simulation for an imaginative examination of possible plans:

a. Original ideas are less likely under stress.

b. Provocative scrutiny of the topic could elicit some novel proposals.

Chapter 4

Economic Stability

BACKGROUND

Although the developing science of earthquake prediction holds promise as a life- and property-saving measure, a credible prediction may cause severe economic repercussions in the area of the predicted quake. If not held in check, these repercussions might be considerably more severe than those caused by the earthquake itself. The degree of severity will depend on: the credibility of the prediction, the projected magnitude of the earthquake, the amount of lead time, the protective laws in effect, and the extent to which the public can be 1) educated about the actual risks involved, and 2) motivated to act responsibly.

If the prediction is believable and the magnitude sizeable (8.0+ on the San Andreas fault or 6.0+ on one of the numerous faults within the metropolitan area), the economic repercussions could be severe. The longer the lead time, the greater the possibility of economic and social disruption.

For a prediction to be productive rather than counterproductive, local governments in a potential "target" area must formulate an adequate prediction response plan and find the means to finance its implementation before a warning is issued. Planning to counteract negative reactions to a prediction adds another dimension to an already large task.

Following a credible prediction, the state could provide special technical and financial aid to a "target" community if the State Legislature would appropriate the necessary funds.

At present, the federal government has little responsibility for what happens in a community prior to a disaster. However, if Congress becomes convinced that the impacts of an earthquake prediction are so extensive that state and local resources cannot cope with them, they may be persuaded to provide assistance.

ISSUES AND RECOMMENDATIONS

ISSUE #1: Economic Decisions

Important economic decisions will be influenced by a credible earthquake prediction. Business firms whose facilities, equipment, investments and personnel are geographically dispersed will have fewer concerns and problems than strictly local companies. Because their overall financial structure is less dependent on what happens in Southern California, these organizations are less threatened by potential disasters. Also, since their economic decisions are often made years in advance, they are more likely to be affected by a prediction with a long lead time than by a short lead time. A warning of three or more years, however, may result in a flight of capital when these larger companies divert investments from the target area, a tendency which might persist until the predicted earthquake occurs or the prediction is no longer credible. On the other hand, if key facilities (such as a computer system) are located in the "target" area, the threat of an earthquake is very real. Financial plans, future investments, and proposed new construction may have to be reassessed. When time permits, certain business interests may migrate out of the area.

Some local businesses will benefit from a credible earthquake prediction. They can reduce potential losses by reducing inventory or by providing special protection to equipment and stock. Facilities may be temporarily relocated, and marginal businesses may be closed. Investment and construction plans may be delayed or altered.

Immediate financial effects will include a delay in purchases and a simultaneous increase in money going into savings accounts, a decrease in money available for loans, and a flight of capital away from the area. Rather than face the problems of absenteeism, firms may encourage employees to take vacations during the prediction time window.

While these responses will benefit the businesses involved, their effect on the community may be generally unfavorable. The area may be hit by problems of rising unemployment, as well as declining sales and property values which would lead to declining tax revenues, despite the need for increased public services.

Recommendation #1: The Mayor should take the lead in educating the public to the real dangers involved in both earthquakes and earthquake predictions. Studies show that, in a variety of wartime and peacetime disasters, an informed public has resisted the urge to panic and has acted responsibly.

Recommendation #2: Business establishments which demonstrate civic responsibility in responding to an earthquake prediction should be given public recognition.

Recommendation #3: Key spokesmen from the private sector should be invited to participate in industry study groups. Representatives from insurance companies, lending agencies, building industries, etc., should be included. They should participate in the development of a coordinated earthquake prediction response plan and appoint persons to serve as a liaison between the private sector and local government.

Recommendation #4: A joint government and private commission could perform a valuable service in monitoring the economy in the threatened area to 1) detect early signs of change, and 2) offer advice to government, business, and labor organizations as needed. Based on their assessment of a specific set of circumstances, this group could recommend whether to sustain a particular community or allow and encourage the orderly outflow of capital and population. Without such a decision, contradictory plans could bring economic chaos to a target area.

Recommendation #5: To allay the fears of the business community, the Mayor should seek legislation which would:

a. Permit the anticipated earthquake site to be designated a "disaster area" once a major prediction is verified and before the actual earthquake occurs, thereby freeing federal funds for preventive actions. (See Chapter 5, Issue 11.)

b. Establish a national program of Natural Catastrophe Insurance. (See Issue #4 for details.)

c. Guarantee the loans and obligations of lending institutions in areas of predicted earthquakes. (See Issue #5.)

ISSUE #2: Employment

Unemployment in some sectors will certainly increase after any credible prediction, regardless of the lead time. When the lead time is short, employers in hazardous buildings will probably close down or substantially curtail operations. If they don't, employees may refuse to come to work. Even those employers housed in relatively safe buildings may close or curtail their operations temporarily with layoffs or forced vacations.

For predictions with longer lead times, unemployment will increase as a result of financial decisions prompted by the prediction. The construction industry will be greatly affected. Even though the prediction may generate some employment in the strengthening of existing structures, businesses will postpone expansion plans, and building officials or engineers may discourage new construction as the target time nears. Marginal businesses will fail as a result of the flight of capital and decreasing sales. As business in general suffers from decreased spending, unemployment will grow, depressing the business climate still further. The downward trend will be difficult to stop.

Recommendation #1: Use federal disaster funds to implement public response plans and upgrade hazardous structures in preparation for the predicted quake. Projects of this nature could provide employment opportunities.

Recommendation #2: Promote the provision of adequate unemployment compensation or extend unemployment eligibility in the event of a long-term prediction.

Recommendation #3: Seek state or federally funded public works projects to create employment opportunities.

ISSUE #3: City Finances: Taxes

Based on the valuation of real property, property tax revenue could decline as residents and businesses move out of a prediction zone and others hesitate to move in. It is unlikely that values would drop appreciably for a lead time of less than one year. A three-to-five year advance notice would probably cause the greatest decline.

Revenue from the taxation of inventory would decline more quickly than property tax income, with a warning period of about two years expected to produce the maximum impact. Revenue from sales tax would probably decline immediately for prediction lead times of less than one year. Income tax receipts would decline as unemployment increased; revenues from permits and licenses would be similarly affected.

Recommendation: The Mayor's Office should seek state or federal grants to compensate the City for lost revenues. The funds would probably need to be earmarked for specific uses such as prevention of earthquake damage and economic stabilization.

ISSUE #4: Public Services

To the extent that funds for public services depend on tax revenue and the sale of permits and licenses, the services may diminish due to a loss of those revenues when a credible prediction is issued. Thses services are likely to decrease only when long warning periods are involved. Unfortunately, the demand for public services will probably increase in response to the prediction.

Recommendation: Priorities for public services may need to be reevaluated and State or Federal funding sought for important new earthquake-related services, or for the continuation of vital ongoing programs.

ISSUE #5: National Disaster Assistance

The chain of economic decisions triggered by a prediction could culminate in effects that assume the proportions of a disaster. Heretofore, federal disaster assistance has been made available during or following a natural or physical catastrophe. The gradually increasing economic effects of an earthquake prediction will not be as obvious or dramatic as calamities that currently inspire the granting of disaster assistance. Nevertheless, the cumulative effects will warrant post-prediction, pre-earthquake support to help the community maintain a reasonable level of economic stability.

Recommendation: Following a major prediction, the Mayor's Office should 1) request that the affected community be declared a disaster area, and 2) apply for a disaster assistance program to make Federal funds available for:

a. the maintenance or augmentation of necessary City services;

b. the availability of unemployment insurance;

c. prudent hazard reduction, for example, the upgrading of hospitals, power stations, Emergency Operation Centers, and other vital service facilities; and

d. the continuation of public works programs and similar aids.

ISSUE #6: Natural Catastrophe Insurance

With the authenticated prediction of a major earthquake, insurance companies are likely to stop issuing new earthquake insurance in the target area. Renewal of existing policies may also cease, and some may even be cancelled. Even if certain companies were willing to issue earthquake insurance, the State Insurance Commissioner would order that no new policies be issued. This directive would prevent the subsequent insolvency of companies should large numbers of costly claims be filed on the new policies.

Without any available earthquake insurance, lending institutions will provide few (if any) loans for buildings or operations within the target area. Real estate transactions and business activities could become extremely difficult at a time when greater flexibility is needed.

If reliable earthquake insurance were available, lending institutions should be willing to make investment loans, though perhaps more selectively or with higher down payments required than under non-prediction conditions. In addition, property owners could pay for their own earthquake coverage, thereby reducing the eventual demand for federal disaster assistance.

Recommendation: Various options for reliable earthquake insurance should be investigated, and a workable program developed and promoted. A national program of Natural Catastrophe Insurance (modeled after the Federal Flood Insurance Program) will probably be necessary. It would be able to provide a base of coverage broad enough to prevent a single disaster from bankrupting the entire program.

ISSUE #7: Loan Guarantees

An earthquake prediction will stimulate a reevaluation of loans by mortgage holders, loan recipients and lending agencies. Borrowers will have reason to consider whether or not they should continue payment, and some may have difficulty keeping up with their obligations. Among other alternatives, lenders will consider the wisdom of discounting loans to stimulate payment as well as the uncertainty of making new or pending loans, even with modified stipulations.

The reactions of borrowers and lenders may be so diverse and chaotic as to require stabilizing measures.

Recommendation #1: Study the possible forms and mechanisms for loan guarantees to stabilize property values.

Recommendation #2: The Mayor's Office should seek federal and state assistance in establishing an adequate program of loan guarantees.

Chapter 5

Governmental Coordination and Legal Aspects

BACKGROUND

In the event of a reliable earthquake prediction, an effective response will require that local governments in the target area develop an organized, coordinated plan, both within and between their respective jurisdictions. At present, many of the necessary structures for the formulation and implementation of a response plan do not exist. In addition, certain quasi-legal/legislative ambiguities limit the preparatory actions that local officials might take in responding constructively to an earthquake prediction.

Clarification of the powers and immunities granted to the Mayor and the City as a result of an earthquake prediction is needed.

ISSUES AND RECOMMENDATIONS

I. FRAMEWORK OF AUTHORITY

ISSUE #1: Authority for Issuing Earthquake Warnings

An organized structure now exists to respond to an actual disaster, but there is no clear authority to initiate and direct the response to an impending catastrophe -- i.e., an earthquake prediction. The responsibility for issuing warnings at the local level is not clearly defined. Currently, there is no provision for such action in the City's Civil Defense and Disaster Ordinance. There is some question as to whether this authority is sufficiently protected by SB 1950 (Alquist), which adds Section 955.1 to the Government Code and allows state and local government officials, while acting responsibly and within the scope of their authority, to take reasonable and necessary actions in response to an earthquake prediction without fear of personal or local jurisdictional liability. According to the State Attorney General's Office, at present only the Governer has clear authority to issue an earthquake warning and invoke emergency procedures.

Recommendation #1: The legal authority of the Mayor to take action in the event of an earthquake prediction should be clarified.

Recommendation #2: Amend the City's Civil Defense and Disaster Ordinance to include authorization for the Mayor to issue a local earthquake warning and to activate the Civil Defense and Disaster Board and the prediction response plan when a reliable earthquake prediction is issued.

Recommendation #3: It will be necessary to clarify both the respective responsibilities of each level of government and the recommended procedures for issuing earthquake warnings and initiating various response plans.

ISSUE #2: Earthquake Prediction Advisory Committee

The City currently has little expertise or experience in dealing with earthquake predictions or with the wide variety of issues that will arise following a prediction.

Recommendation: Establish an Earthquake Prediction Advisory Committee to assist the Mayor and the Civil Defense and Disaster Board in responding to any earthquake prediction. After studying the specific characteristics of the predictions, the advisory committee could advise the Mayor and other officials on the level and nature of response that would be appropriate.

It may happen that the prediction of a reputable scientist is rejected by CEPEC, but continues to have the full support of the person or institution which issued it. Media publicity for a prediction may have aroused the concern of the public, establishing a credibility which may be maintained despite CEPEC's position. In this case, the advisory committee could propose a low-level response plan to allay the people's fears and help them be better prepared for any earthquake.

The advisory committee could also help in assessing the confidence of the people and the probable impact of a confirmed prediction.

Structural engineers, seismologists, geologists, legal counsel, business and community leaders, and representatives from the utilities could be included on the committee. The group should report to the Mayor, and at his option, to the Civil Defense and Disaster Board.

ISSUE #3: Monitoring the California Earthquake Prediction Evaluation Council (CEPEC)

At present, the discussions and prediction evaluations of CEPEC take place without the participation of the City of Los Angeles.

Recommendation: The Mayor should have a representative to serve as a monitor or observer of CEPEC proceedings. This representative should not be a member of CEPEC, but should have the requisite knowledge to comprehend and appreciate their discussions. He or she may come from within City government if he is qualified to understand CEPEC deliberations and has the confidence of the Mayor. The insights gained by the observer could be useful to the City's Advisory Committee and other groups in preparing a prediction response. A CEPEC observer could be designated immediately, without waiting for further study.

ISSUE #4: Coordination With City Council

The City Council is as much a governing body as the Mayor's Office. Without their cooperation, very few programs can be implemented successfully.

Recommendation #1: Transmit copies of the Earthquake Prediction Task Force Report to each member of the City Council as background and support for any subsequent ordinances, programs or budgetary requests.

Recommendation #2: When prepared, the Earthquake Prediction Response Plan should be submitted to the Mayor and City Council for approval.

ISSUE #5: Intergovernmental Cooperation

Since the prediction of a damaging earthquake in the Los Angeles area is likely to include jurisdictions other than the City, intergovernmental cooperation will be essential in implementing an effective response. If actions taken or recommended by the City do not receive at least philosophical concurrence from adjacent jurisdictions, public credibility could be seriously undermined and the effectiveness of advised actions substantially reduced. If a basis for intergovernmental cooperation is not established prior to the issuance of a prediction, when a crisis situation develops, much valuable time will be lost and levels of cooperation will probably be reduced.

Recommendation #1: To overcome jurisdictional fragmentation with respect to information, response capabilities and responsibilities, the Mayor should convene an intergovernmental agency meeting in order to share information which will facilitate a uniform or coordinated response by decision-makers from all affected jurisdictions. This coordination should be established well in advance of any prediction.

Recommendation #2: To prepare for the intergovernmental agency meeting, representatives of the Mayor should conduct seminars with these outside jurisdictions to inform them of the findings of the Earthquake Prediction Task Force.

ISSUE #6: The City's Liability in Responding to a Prediction

There are questions as to the City's liability when acting or failing to take action in response to an earthquake prediction, particularly if the Governor does not issue a warning. A study in progress by the Association of Bay Area Governments (ABAG) has found no clear legal authorization for the City to invoke emergency measures before an earthquake occurs. The Office of the State Attorney General indicates that Cities are not strictly immune to liability for such actions or inactions.

Recommendation: SB 1950 (Alquist) should be clarified or amended. At present, the bill appears to grant clear immunity from liability for taking discretionary action in response to an earthquake prediction only to the Governor. The California Office of Emergency Services is considering revision of the bill to further clarify the action or non-action for which immunity is provided. The City should actively support this revision and monitor its content.

Another approach would be to secure "state of emergency" status for a prediction period, thereby gaining full immunity for local officials when they take responsible action to assure the public safety. Some attorneys believe that this was the original intent of the State legislature in passing SB 1950 (Alquist).

ISSUE #7: Liability Related to Hazard Mitigation

It seems that the more the City does in the way of hazard mitigation, the more liability it could incur. For example, the fact that the Department of Building and Safety has conducted a survey of hazardous buildings creates the expectation that something will be done to alleviate the dangers that have been identified. This is especially true in situations of involuntary occupancy (prisons, sanitoriums, etc.). Also, a prediction with adequate lead time for remedial action could increase the potential liability of local government if appropriate actions were not initiated.

In City-owned buildings, the City is responsible for damage or injury only if it can be proved negligent. Workers compensation would probably cover public and private employees injured in a predicted earthquake while on the job, but it would not necessarily absolve the City of responsibility for their safety.

Recommendation #1: As a general approach, a specific prediction response should aim for the greatest benefits with the least permanent disruption. Where resources are limited, priorities for mitigation should be established, based on the greatest saving of life and increased speed of post-earthquake recovery, with as little permanent disruption as possible.

Recommendation #2: A policy of advising rather than mandating action will create less liability and is especially appropriate for a prediction with only a moderate level of probability.

Recommendation #3: Requiring that action be taken (e.g., upgrading) rather than actually performing the action would lessen the likelihood of recrimination against the City.

ISSUE #8: Liability Related to Damage Maps

The availability of earthquake damage prediction maps would facilitate the City's prediction response and increase inter-agency coordination by focusing complementary efforts in areas of greatest need. (See also Chapter 10, and Chapter 3, Issue #9.) However, there may be liability problems involved in the preparation and use of these maps.

Recommendation: The City should sponsor or promote the preparation of earthquake damage prediction maps, contingent on satisfactory answers to the following legal questions:

a. What liability would the City incur in publishing these maps? If a certain property decreases in value as a result of information on the map, is the City responsible?

b. Is the City's liability less if the maps are prepared, but made available only on request?

c. What liability is incurred if the maps are used governmentally in connection with a prediction?

d. What liability is incurred if the general data is in City files and the City fails to take action?

e. In order to reduce or avoid liability, what precautions should be taken in preparing and issuing the maps?

OTHER LIABILITY ISSUES

1. If specific neighborhoods are evacuated by a City order, what responsibility does the City have to protect property in that area?

2. When an evacuation order is issued in response to a prediction as opposed to an impending disaster such as a flood, do the police have the power to demand compliance?

3. If the Governor does not issue a warning, but the Mayor decides to do so and subsequently takes appropriate actions, what are the City's liabilities?

4. What might be the City's liability if the Mayor chooses not to act either when the Governor does or does not issue a warning?

ISSUE #9: Liability of the Press and Scientific Community

Scientists and public officials who release predictions or issue warnings that turn out to be false alarms or erroneous in some significant respect are concerned over whether they incur liability to those who suffer damage or injury because of the prediction or warning.

Tentative Conclusions:

1. In most cases, the publication of such notices should not create liability, provided the announcements are conscientiously issued, based on adequate evidence, and appropriately couched as fallible judgments rather than established facts.

2. If a prediction or warning is withheld for fear of public harm, or to the advantage of special interests, and the earthquake occurs, the possibility of incurring liability may be substantial.

ISSUE #10: Economic Repercussions

A long-term prediction is likely to set up a chain of economic reactions that could depress property values, employment levels, tax revenues and business viability. (See Chapter 4.)

Recommendation: The City should evaluate its options, establish policy, and secure the necessary legal authority to initiate measures designed to offset extreme and detrimental economic reactions. State and Federal legislation should be sought where necessary.

ISSUE #11: Pre-Earthquake Disaster Assistance

The Federal Disaster Relief Act of 1974 allows the President to declare a Federal emergency for specific disaster areas and make Federal disaster assistance available to the affected area. This authority has also been used to a limited extent immediately preceeding a forecasted disaster such as a major flood or hurricane, but the applicability of the act to a longer-term earthquake prediction is not certain.

Recommendation: Policy or legislative clarification should be sought to clear the way for Federal disaster assistance following the verification of a prediction of a damaging earthquake by CEPEC. Federal guidelines for the appropriate use of such funds may also be necessary.

Chapter 6

Safety of Buildings

BACKGROUND

One of the greatest threats to life and safety during an earthquake is the possibility of building collapse. The earthquake resistance of buildings in Los Angeles varies from highly vulnerable to quite resilient. With a specific forewarning of a major earthquake, there would be greater impetus to correct some hazardous conditions, and to discourage the use of unsafe structures.

The greatest potential benefit from the promotion of earthquake-resistant buildings is a substantial reduction in human injury and loss of life. Modern buildings are designed to prevent all but minor (surficial) damage during a moderate earthquake, and to provide sufficient strength that the building will remain standing and allow safe exit of occupants after a major earthquake (although the building would not necessarily remain functional for normal use). The upgrading of vulnerable buildings will therefore provide a substantial savings in death and injury, with some reduction in the level of property damage, but a major earthquake could still produce high dollar losses in building damage.

To identify the areas of greatest concern for life and safety, the standards used in the construction of buildings of various types and ages were reviewed. Unreinforced masonry buildings, erected before 1934 when there were no earthquake resistance requirements, are considered to be the most likely to collapse in a strong earthquake. The potential structural and mechanical problems peculiar to buildings of other ages were also examined by the committee. A survey of interior hazards resulting from the arrangement of furniture, appliances, and fixtures completes this study of building hazards.

At about the time the Earthquake Prediction Task Force was convened, a separate study of unreinforced masonry buildings was initiated by the City Council. A preliminary draft of the study, containing code proposals for the upgrading of the buildings, is now completed. (See: Preliminary Draft Approved By the Technical Subcommittee of the Earthquake Safety Study Committee, January 30, 1978, Division 68 -- Earthquake Hazard Reduction in Existing Buildings.) A building-by-building survey of the estimated 9,000 unreinforced masonry buildings in the City is scheduled for completion by early 1979. Social, economic, and environmental assessments of the proposed correction code are scheduled or underway. If a correction code for unreinforced masonry buildings is adopted, enforcement probably will take place in several stages over a period of years or even decades.

In preparation for a credible earthquake prediction, the City needs to enact the necessary codes to establish standards for earthquake safety, as well as procedures, priorities, and timetables to serve as guidelines in the enforcement of these standards. An ongoing program should be initiated as soon as possible to identify and upgrade unsafe structures. Once the basic standards and priorities are established, augmentation or acceleration of the program can be implemented as appropriate in response to a specific earthquake prediction. The City should also seek, in advance, emergency funding sources to be called upon at the time of a substantial prediction. In addition, both owners and occupants should be encouraged to correct interior hazards caused by equipment, fixtures, and furnishings. The fact that we live in an earthquake prone area should provide the motivation to activate both public and private sectors of the community.

When a prediction is issued, the City should immediately solicit emergency funds to be used in an accelerated program of structural upgrading, based on pre-established priorities. All feasible means should be employed to hasten this program in order to protect occupants in the most practicable way. Existing deadlines should be reevaluated, along with some reevaluation of priorities, and at the appropriate time, hazardous buildings could be evacuated. A long-term prediction would provide an opportunity to reinforce some hazardous structures and to locate housing for residents of buildings that may fail during the earthquake. A short-term warning could allow people to relocate temporarily or to postpone business in hazardous structures. Knowing which buildings are basically safe would help reassure residents, and, in comparison, would focus attention on buildings with substantial hazards.

ISSUES AND RECOMMENDATIONS

I. POTENTIAL BUILDING HAZARDS RELATED TO DATE OF CONSTRUCTION

This section is divided into dates of construction related to major changes in the Los Angeles Building Code. There are likely to be individual buildings that provide both positive and negative exceptions within each category.

ISSUE #1: Pre-1934 Buildings

Unreinforced masonry buildings (built before 1934) pose the greatest life hazard in an earthquake.

Recommendation #1: Considering such factors as ease of rehabilitation, type of occupancy, and socio-economic needs of the community, priorities for reinforcement, decreasing occupancy levels, or demolition should be established before we are confronted with a credible earthquake prediction. It is generally agreed that our priorities are: first--people, second--vital service buildings, and third--other buildings. The Earthquake Safety Study Committee, in the preliminary draft of their report (January 30, 1978), proposed the following Priority Rating Classification:

I. Essential Facilities (See Vital Structures, p. 24 of this report).

II. High Risk Occupancies -- 100 occupants, used more than 20 hours a week.

III. Medium Risk Occupancies -- 20 occupants or more.

IV. Low Risk Occupancies -- less than 20 occupants.

When a scientifically valid long-term prediction is issued, the enforcement of a Seismic Safety Code could be acclerated according to these priorities.

Recommendation #2: Develop a contingency plan for accelerating implementation of the pending unreinforced masonry code in the event of a credible earthquake prediction. The plan should include options for upgrading, vacating, or demolishing buildings that have not yet complied with the code.

The report of the Earthquake Safety Study Committee, mentioned above, includes (1) detailed suggestions on procedures for issuing orders to demolish or repair unreinforced masonry buildings, (2) analysis and design requirements, and (3) recommended construction materials.

Recommendation #3: Maps should be prepared to show where hazardous housing structures are located. Develop an evacuation plan to allow for the orderly movement of the occupants of these buildings to safe areas in the event of a valid prediction. Information indicating which structures and areas are expected to be safe in an earthquake should be widely distributed following a major prediction.

Recommendation #4: Take advantage of lead time to plan for long-term relocation of those individuals whose housing may be destroyed by an earthquake or condemned as a result of one. (Tens of thousands of people may require housing following a very large local earthquake.)

ISSUE #2: 1934-1959 Structures

After the 1933 Long Beach earthquake, new buildings were required to be resistant to lateral earthquake forces. Limited to 13 stories in height, these structures were designed in accordance with known earthquake concepts and building codes of that time. There may be some internal hazards related to the safe-exiting provisions and the mechanical components of these structures (elevators, electrical systems, fire suppression systems, etc.). However, the materials and design utilized during this period make these buildings relatively earthquake safe. A valid earthquake prediction could provide the stimulus for building owners and lessees to evaluate and correct the earthquake performance of their older mechanical systems.

Recommendation #1: Develop criteria and guidelines for upgrading the mechanical systems of structures built between 1934 and 1959. Include a methodology for the evaluation of the potential hazards of the following: (1) mechanical equipment performance, (2) utility connections and shut-offs, (3) safe exit, (4) fire safety, and (5) collapse resistance factor. In addition, suggestions should be formulated for any improvements, rehabilitation, and strengthening that will produce greater safety. These guidelines should be established now, so that implementation may begin.

Recommendation #2: Encourage voluntary upgrading prior to a verified prediction.

Recommendation #3: Evaluate alternate means of enforcing Building and Safety Department orders to repair or demolish buildings that do not meet seismic force requirements. After a prediction, certain types of upgrading could become mandatory and specific deadlines for compliance defined.

ISSUE #3: 1959-1973 Structures

In 1959, the 13-story height limit was lifted as earthquake design standards were modified. With the advent of high-rise buildings, additional problems evolved. During an earthquake, furniture moved as a result of the great "sway" of the buildings, and the logistics of fire-fighting and emergency exits became more complicated. The earthquake force factor assumed to be adequate and utilized for design between 1959 and 1973 was lower than the factor accepted and used today.

Recommendation #1: These buildings should be evaluated in terms of important differences between the 1959 codes and current building codes. The evaluation should include:

a. The capability of providing safe exit, with reference to elevators, stairways, exit doors, and crowd control.

b. Fire suppression capabilities -- with special attention to structures over 12 to 16 stories in height, water sources, presence of flammable materials, utilities, equipment, and other fire related factors.

c. Utility safety, with specific reference to gas pipelines and gas fixtures.

d. The use of automatic shut-off valves for gas and electrical systems, with reference to the possible need for redesign of shut-off valves to be triggered only by large, damaging earthquakes.

e. The need for anchoring of furniture, fixtures, equipment, and utilities.

f. Occupant safety relative to building motion.

g. Distribution of information to occupants on special, orderly exiting procedures following an earthquake.

Recommendation #2: Voluntary improvements of the deficiencies revealed by the above evaluation should be encouraged.

Recommendation #3: At the time of a prediction, the repair of the most hazardous deficiencies should be ordered and a time limit placed on compliance.

ISSUE #4: Post-1973 Structures

Based on problems ecountered in the 1971 San Fernando earthquake, new earthquake design requirements were introduced in 1973 and 1974 as a result of the recognition of a greater severity of ground motion in the vicinity of the epicenter. Fire codes for high-rise structures were also strengthened.

Recommendation: The performance of these buildings during earthquakes should continue to be evaluated. Deficiencies discovered could be repaired on a voluntary basis before a prediction is in effect. The correction of major deficiencies could be required during a prediction period.

II. SPECIAL PROBLEM AREAS

ISSUE #5: Wall Anchorage

The purpose of wall anchorage is to securely connect heavy masonry or concrete walls to the roof and floor framing of a building, thus preventing the wall from pulling away from the framework. The anchor itself consists of a steel strap or bar that is embedded into the wall, then nailed or bolted to a roof or floor framing member. The embedded end of the anchor is equipped with a hook or bolt to increase pullout resistance. Anchors are usually spaced about four feet apart around the floor and roof perimeter. Any existing anchors in unreinforced masonry buildings may be inadequate due to weak mortar and lack of pullout resistance. (In 1973, the City Building Code was amended to require wall anchors in all new construction; Code Section 31.2306b.)

Recommendation #1: All buildings constructed prior to 1973 should be retrofitted with wall anchors. An ordinance to this effect should be developed. In unreinforced masonry buildings, additional anchors that pierce through the entire wall may be required.

Recommendation #2: Information on the importance and installation procedures of wall anchors should be circulated. Voluntary retrofitting should be encouraged before a prediction, and corrections could be required after a warning is issued, if there is adequate lead time.

ISSUE #6: Deterioration of Wood Trusses

Long-span trusses, which were common in construction of the 1940's and 1950's can develop splits and cracks in the chord members and at connections.

Recommendation: All wood trusses should be closely inspected. Where defects are noted, repairs should be made or the members replaced. All bolted connections should be checked for tightness. These corrections could become mandatory after a prediction is announced.

ISSUE #7: Rod Bracing Systems

Many buildings have rod bracing systems which are intended to resist earthquake forces. These usually consist of cross braces with adjustable turn buckles on each rod.

Recommendation: In response to a prediction, rod systems should be checked to make sure they maintain the design tension.

ISSUE #8: Building Hazards

Deficiencies in existing buildings may include:

a. inadequate or worn-out support systems,
b. lack of proper exiting facilities,
c. physical deterioration,
d. inadequate protection against fire.

Recommendation: All deficiencies which jeopardize the security of life and property should be identified, then corrected on a voluntary basis prior to an earthquake warning. During a prediction period, correction of life-safety hazards could be required.

ISSUE #9: Suspended Ceiling Systems

Some buildings with suspended ceiling systems constructed prior to 1974 do not have lateral support wires to prevent the ceiling from buckling and collapsing during an earthquake. In 1974, the Department of Building and Safety adopted RGA 4-74, which requires lateral support for all suspended ceilings larger in area than 144 square feet.

Recommendation: These provisions should be extended to apply to suspended ceilings installed prior to 1974. Compliance should be required when an earthquake warning is in effect, if not sooner.

ISSUE #10: Rooftop Mechanical Equipment

Many buildings, particularly older structures, have accumulated considerable mechanical equipment on their roofs.

Recommendation: Owners of buildings with extensive roof-mounted equipment should consult a licensed engineer to determine whether their roof system is adequate for the superimposed loading and whether the equipment is properly anchored. When a prediction is verified, necessary adjustments should be ordered, if they have not already been completed.

ISSUE #11: Metal Lath

Many buildings constructed prior to 1934 have plaster ceilings with metal lath supported by wood joists. Past experience has shown that where the attachment of the metal lath to the wood joist is only by vertical nailing through the metal, a very dangerous condition exists.

Recommendation: These ceilings should be reanchored to positively support the ceiling load. In buildings where this has not been done by the time a prediction is confirmed, reanchoring should be compulsory.

ISSUE #12: Gas Shut-Off Valves

Gas lines may rupture during an earthquake, leaking highly flammable, noxious gas into the environment.

Recommendation: Encourage the development and marketing of well-designed automatic gas shut-off valves. These new valves should be designed to go into action only after strong earthquake shaking of a duration which would normally cause earthquake damage. Triggering by a passing truck or accidental bump should not be possible. Under conditions of an earthquake prediction, installation of shut-off valves could be strongly encouraged.

ISSUE #13: Elevators

New standards for the seismic safety of elevators have been proposed by the Los Angeles Department of Building and Safety. Based on empirical evidence carefully derived from first-hand surveys of the damage caused by the 1971 San Fernando earthquake, the new code requires retrofits according to the California Administrative Code, Title 8. Its coverage of other safety features, however, is different from the state regulations. Protective devices such as an early detection seismic switch, collision and derailment warning switches, signal devices, and special equipment

guards would be required. The object of each requirement is to insure the safety of the occupants of an elevator during and after a severe earthquake. These various mechanical components are designed to stop the operation of the car, holding the people inside until they can be unloaded without harm.

Recommendation #1: The City Council and Mayor should approve the new elevator code at the earliest opportunity so that compliance with its standards may begin and postponement of its proposed compliance deadline of October 6, 1980, can be avoided. The Earthquake Prediction Response Plan could include provision for accelerating enforcement deadlines if a major local earthquake is predicted.

Recommendation #2: The public should be forewarned that following an earthquake, elevators will not be operating and should not be used until they are checked for safety.

III. POTENTIAL HAZARDS TO VITAL STRUCTURES

Buildings that provide vital services have special value to the community in the wake of a disaster. Hospitals and emergency response facilities are especially important to post-disaster operations, and structures with involuntary occupancies (nursing homes, schools and jails) may require special attention to the safety of their occupants. To maintain the post-disaster effectiveness of vital structures, it is necessary not only to assure their continued functioning, but also to offer a reasonable degree of safety to the people who use them. A prediction will allow time to help accomplish this.

ISSUE #14: Hospitals

In the target area, it is essential that hospitals remain functional after the earthquake.

Recommendation #1: Hospitals should be surveyed to determine (1) which will probably remain functional, (2) what type of services each will be capable of dispensing, and (3) their accessibility during and after an earthquake. Contingency plans should then be designed with the functionality factor in mind. When a prediction is issued, the contingency plans can be adjusted to the specific time, place, and intensity of the anticipated quake and implemented promptly.

Recommendation #2: The Mayor should consider City-sponsored or supported legislation which requires existing hospitals to comply with current earthquake safety building standards. This legislation should include an appropriation for financial assistance to all public and private hospitals to facilitate this upgrading, as both public and private hospitals perform crucial services in the emergency aftermath of an earthquake. Upgrading should be implemented as expeditiously as is practicable.

Recommendation #3: Following a prediction, vital supplies stored in vulnerable structures should be relocated.

Recommendation #4: In response to a prediction, hospitals outside the target area should be prepared to provide temporary additional service.

Recommendation #5: Emergency power sources should be checked in hospitals expected to remain operative. Larger stand-by fuel supplies may need to be arranged.

Recommendation #6: When an earthquake is imminent, long-term and life-support patients could be relocated out of the prediction area; patients should be released whenever possible, and elective surgery should be postponed.

ISSUE #15: Emergency Headquarters

The Mayor's Command Post, Police and Fire Command-Dispatch Centers, Telephone Communication Centers, and Public Utility Emergency and Command Centers are vital to earthquake response.

Recommendation: The earthquake resistant capabilities of these structures should be evaluated. Those that are not likely to withstand a damaging earthquake should be rehabilitated or replaced. When a prediction is received, plans should be accelerated or vital services relocated.

ISSUE #16: Non-Voluntary Occupancy

Structures such as private schools, nursing homes, sanitariums, and detention facilities should be checked for seismic safety. (The City has no authority over public schools, which are regulated by the State.)

Recommendation #1: Inspect and evaluate these buildings with regard to structural integrity, exiting facilities, and fire protective construction.

Recommendation #2: Encourage the rehabilitation of those found deficient, and require that major hazards be corrected or eliminated. Expedite compliance when a prediction is verified.

Recommendation #3: Where life hazards remain, facilities should be vacated as the target date nears.

Recommendation #4: Detention facilities should be extremely earthquake resistant, even to potentially hazardous but non-structural damage. Ideally, they should not require evacuation or excessive surveillance during the emergency. Work towards this goal, and expedite progress after a prediction. Long-term prisoners in substandard facilities could be relocated outside the prediction area as an earthquake becomes imminent.

ISSUE #17: City-Owned Buildings

The City owns almost 200 unreinforced masonry buildings which are vulnerable to collapse in an earthquake. Of these, a number house fire and police stations and other facilities of critical importance to an earthquake recovery effort. Other hazardous structures are used as offices, libraries, and other high occupancy uses. The current program to replace these buildings is proceeding slowly because funds must be found in the capital improvement budget.

Recommendation #1: When a major long-term prediction is verified, the replacement effort must be accelerated.

Recommendation #2: As the predicted time draws near, offices and vital facilities should be temporarily relocated, perhaps to temporary buildings brought in for this purpose.

Recommendation #3: Federal funding should be requested for substantial preventive actions taken in response to a prediction.

IV. GENERAL RECOMMENDATIONS

ISSUE #18: Coordination

Coordination with various state and county agencies, city departments and volunteer organizations will facilitate the judicious, efficient use of available resources.

Recommendation #1: Formulate and implement plans for cooperation among these groups for evaluation, remedial work, and relocation of essential facilities, beginning in the pre-prediction planning stage.

Recommendation #2: Investigate which professional organizations can provide expert advise to help City departments. Call on them for assistance in planning and implementation, before and after the prediction.

ISSUE #19: Public Inquiry

Immediately after a prediction is made, the public, City officials, and the news media will demand to know what is being done to insure the safety of the buildings they occupy.

Recommendation #1: Affected City departments should cooperate in the development of a contingency plan now to help assure the safety of building occupants in an earthquake. The plan should include procedures for evaluating the structural stability of buildings and identifying areas of potential architectural and decor hazards within buildings, and mitigating measures could be taken. The plan should address the safety of private as well as public buildings, and be suitable for implementation either before or after a prediction is made.

Recommendation #2: When an earthquake is predicted, the Mayor should direct City departments to implement the contingency plan for all public buildings. He should urge owners to expedite upgrading to comply with the latest Building and Safety regulations. Occupants should be actively encouraged to follow recommended safety precautions in preparing interiors for the impending earthquake.

Recommendation #3: Appropriate City departments should prepare lists of hazardous items which could be corrected within the time frame of the prediction, and complete such correction.

Recommendation #4: Rather than wait for "disaster relief" after the event, the Mayor should support legislation which will make funds available for hazard reduction prior to the earthquake, especially in response to a verified prediction.

ISSUE #20: Securing Citizen Cooperation

Everyone can participate in preparing the buildings in which they live and work to better withstand a damaging earthquake. Constructive action by the people can result in substantial hazard reduction in building interiors. In the 1971 San Fernando earthquake, non-structural damage was far more costly than structural damage.

Recommendation #1 - Education: Before and after a prediction announcement, inform the people as thoroughly as possible about the kinds of hazards that may exist in the buildings they occupy, and of protective measures that they may take to increase their safety. Recommend that they plan ahead and implement protective measures as soon as possible, and to institute any additional interim measures as the lead time narrows.

Recommendation #2 - Fire Prevention: Families, offices, etc., should be instructed to:

a. develop a fire response plan;

b. learn how to fight home fires and use home fire equipment; and

c. acquire and store equipment and supplies for quick and easy access.

As the predicted date approaches, they should:

d. assemble and ready supplies for fire prevention and control, for example, a garden hose, ladder, fire extinguisher, buckets of sand, a multi-purpose or crescent wrench (to turn off gas valves), etc.;

e. search homes for fire hazards and eliminate them;

f. provide easy access to safe exits; and

g. provide for safe storage of vital records.

Recommendation #3 - Prevention of personal injury and property damage: In response to a prediction, encourage individuals to:

a. check ceiling support; reinforce if necessary; attach fixtures securely;

b. check for hazardous furniture arrangements (bed should not be under window or bookcase, etc.);

c. secure furniture, appliances, and other heavy objects for greater stability; bolt in tall cabinets and bookcases; bolt down gas appliances;

d. rearrange shelves, placing heaviest objects on bottom; secure bookcases and kitchen cabinets to prevent damaging spills;

e. assemble home care tools: crowbar, asbestos gloves, hammer and nails, pliers, screwdrivers;

f. provide for the special needs of the elderly and the handicapped.

(These suggestions come from "How To Survive An Earthquake," a publication of Creative Home Economics Consultants, Chec Publications, 1977.)

ISSUE #21: Post-Earthquake Evaluation

Immediately following an earthquake, a large number of technically qualified persons will be needed to evaluate structural integrity and incipient hazards. Professional organizations such as the Structural Engineers Association of Southern California have worked with the State Office of Emergency Services in disaster preparedness and disaster response programs.

Recommendation: During the prediction period, arrange for organizations like this to be part of the City's post-earthquake plans.

Chapter 7

Hazardous Facilities and Lifelines

BACKGROUND

Earthquake prediction offers a unique opportunity and time frame for implementing specific measures to (1) safeguard potentially hazardous facilities, and (2) help ensure the continued operation and prompt recovery of essential lifeline facilities. The primary objective of such programs would be life safety. Secondary goals are to minimize social and economic disruption, prevent major health hazards, reduce property loss, and facilitate post-earthquake recovery.

The lifelines of the City are its transportation, communications, water, energy, and waste disposal systems. A major earthquake of Richter magnitude 8.5 on the San Andreas Fault or a magnitude 6 to 7.5 earthquake on one of the local faults would generate strong ground shaking in the City of Los Angeles and could inflict heavy damage to lifelines, particularly those which cross the activated fault zone or are buried and supported on unstable ground. Older facilities such as partially-deteriorated pipelines or unreinforced masonry buildings could be vulnerable even in areas of moderate ground movement. An Earthquake Prediction Response Plan must deal with the protection of these lifelines as well as the fastest possible restoration of service for facilities disrupted by an earthquake.

A wide variety of existing facilities within the City could pose hazards to surrounding areas and demand immediate attention from hard-pressed emergency personnel if those facilities were damaged during an earthquake. Pipelines, refineries, and storage tanks containing gas and petroleum products could be vulnerable to fire or explosion. Some older dams may be vulnerable to damage and potential collapse. Caustic, flammable, and chemically reactive substances are transported, stored, and marketed in many areas of the City for industrial and commercial uses. Radioactive substances used for medical, industrial, and experimental purposes as well as research atomic reactors might produce contamination if their containment facilities were severely damaged.

An Earthquake Prediction Response Plan could ensure that adequate standards are set to prevent critical damage from an earthquake. The plan should establish procedures for rechecking or requiring compliance once a prediction is validated, and should help focus disaster response plans for greater effectiveness in areas most vulnerable to the predicted earthquake.

In order to reduce earthquake hazards substantially, a coordinated, continuing program of hazards reduction must be in effect before a prediction is made. This program should include a response plan of step-by-step procedures to be followed after a prediction is announced. All response plans will need to consider the range of lead times that could be available between a prediction announcement and the anticipated date of occurrence of the earthquake.

In the aftermath of the 1971 San Fernando earthquake, a number of agencies sponsored investigations which analyzed the earthquake damage and made recommendations to increase seismic safety. Public as well as private institutions involved with lifeline facilities, dams, or hazardous materials now have ongoing programs to study and improve seismic safety. With the exception of dams and State highways, most of the current implementation deals with new construction and installations. The more difficult problems of upgrading older facilities have not been adequately resolved.

Industry, businesses, and citizens can play an important role in hazard reduction. They will need to know how to prepare themselves and their communities as well as how to respond in the event of damage to lifelines or hazardous facilities in their vicinity.

ISSUES AND RECOMMENDATIONS

ISSUE #1: Coordination

Many independent organizations and industries are currently reviewing seismic safety standards for their areas of concern, as are numerous public agencies and departments. Some activities have reached the implementation stage, whereas others have only identified some of the existing hazards.

Recommendation #1: The City could assume responsibility for encouraging, assisting, supporting, and coordinating the efforts of public and private lifeline agencies as well as industry to develop specific plans for hazard reduction.

Recommendation #2: The Civil Defense and Disaster Board should be expanded and assigned responsibility for the coordination and monitoring of the various hazard reduction programs.

Recommendation #3: The analysis of specific hazards and planning for their mitigation should be the direct responsibility of the individual agencies and industries concerned, for they have the knowledge and expertise required for this specialized task.

Recommendation #4: The City's Seismic Plan could be used as a guide in organizing all hazard reduction programs. The plan outlines in general terms certain policies and programs to reduce earthquake hazards and to improve performance of lifelines in an earthquake. It should be augmented to include a delineation of potential soil liquefaction areas and unstable ground. A U.S.G.S. or N.S.F. grant might be sought to provide the funding and expertise to do a reliable survey of this complex and rapidly evolving topic.

ISSUE #2: Response Level Geared to Lead Time

A long lead time before the predicted earthquake will allow programs of major upgrading, extensive citizen education, reduction of inventories, and shifting of personnel, supply sources or storage areas. A short lead time would be more compatible with such measures as limited evacuation, temporary shut-down of hazardous facilities, or increased on-call staffing to handle problems as they arise.

Recommendation: Plan various levels of response for each lifeline system or hazardous facility, geared to short, intermediate, or long lead times.

ISSUE #3: Identification and Mitigation of Hazards in the Lifeline Systems

Maintenance of service in all of the lifeline systems is one of the City's highest priorities. The more that can be done in advance to safeguard these facilities, the faster the City will be able to recover from an earthquake.

Recommendation #1: Before a prediction is received, each City department and each private utility should identify specific earthquake hazards to the lifeline systems under its jurisdiction and initiate a program to remedy those hazards. Maps showing where major lifelines within the City cross active faults should be kept current. (California Division of Mines and Geology, Los Angeles County Engineer, the Departments of City Planning, Public Works and Building and Safety all have fault maps for this area.)

Recommendation #2: When a warning is issued, upgrading of hazardous conditions should be expedited.

Recommendation #3: The Mayor's Office should be kept informed of any government or citizen assistance (e.g., evacuation) needed by City departments or private companies.

Recommendation #4: The California Public Utilities Commission and the California Seismic Commission should be consulted and even involved in efforts to assess lifeline preparedness.

ISSUE #4: Safeguarding Hazardous Materials

A wide variety of businesses and industries in the City use, transport, store, or sell materials (primarily fluids and gases) that are caustic, flammable, or highly reactive. In some instances, two or more chemicals stored in close proximity produce hazardous substances only when mixed. Moderate to severe ground shaking during an earthquake can rupture storage tanks and pipelines, create traffic problems that endanger haul trucks, disrupt and endanger rail transport, and cause breakage of bottles and other containers (toppling from shelves could be widespread). Most operations using hazardous materials are technically required to register with the City or County, but enforcement and follow-up is lax in many cases.

Recommendation #1: Preceeding an earthquake prediction, the Fire Department and Building and Safety Department should expand their periodic review and updating of City regulations for the storage and transport of hazardous materials to include an evaluation of the resistance of existing storage facilities and pipelines to earthquake shaking.

Recommendation #2: The Fire Department should maintain an up-to-date record of all buildings and their owners where hazardous materials are stored. Information on the type of hazardous materials to be found at each location should be available in each fire-fighting vehicle or station house.

Recommendation #3: The Fire Department should work with organizations that handle hazardous chemicals to identify specific potential hazards under their jurisdiction and recommend mitigation measures.

Recommendation #4: Fire Department and Building and Safety Department personnel should conduct inspections in selected cases to consider structural as well as material safety at the same time. Major facilities such as gas and petroleum storage areas would warrant such systematic inspections, as would older structures which have hazardous materials inside.

Recommendation #5: The City should establish procedures for business and industry to report potentially hazardous situations that require government or citizen participation for effective mitigation.

Recommendation #6: The Civil Defense and Disaster Board should prepare guidelines or a stand-by ordinance to require all holders of City or County permits for the storage or transport of hazardous chemicals and radioactive materials to prepare plans showing the means they will use to protect their inventory and prevent the escape of hazardous materials during or after an earthquake. Implementation and follow-up would be especially appropriate during the span of a moderate- to long-term prediction.

ISSUE #5: Modification of Existing Facilities

Some earthquake hazards can be reduced only by modifying existing facilities or pipelines. Because a large majority of earthquake hazards are related to older, substandard or deteriorating installations, upgrading efforts are very important. However, the logistical difficulty of the work and the large number of older facilities would require extensive time and financial investment.

Recommendation #1: Encourage upgrading by authorizing funding or a rate increase. Where private utilities are involved, request State assistance to obtain appropriate rate increases from the Public Utilities Commission.

Recommendation #2: Prior to a prediction, establish priorities and procedures for safeguarding critical facilities that may need upgrading work.

Recommendation #3: After a validated prediction is received, special interim measures should be taken (1) to safeguard hazardous facilities that have not received needed modifications, (2) to shift lifeline operations to more reliable facilities wherever possible, and (3) to provide adequate plans, personnel, and supplies for the prompt restoration of lifelines that could be damaged by the earthquake.

ISSUE #6: The Harbor Area

The Los Angeles harbor area is especially vulnerable to earthquakes due to its proximity to the Palos Verdes and Newport-Inglewood Faults, and to geologic conditions which make much of the area susceptible to ground failure, soil liquefaction, and possibly surge waves from seiche action. In addition, the high concentration of petroleum refineries, hazardous chemical plants, storage facilities, pipelines, and fuel unloading facilities intensifies the risk of explosions, major fires that could spread quickly on top of the water, and leakage of toxic materials onto harbor waters, endangering a great number of people. Bridges that provide access to Terminal Island could be damaged, possibly beyond use. Continuing operation of the harbor following an earthquake would be important for the supply of materials, personnel, special equipment, and fuels, and as an avenue for limited evacuation. Major damage to the harbor would greatly inhibit the economic and physical recovery of the area.

Recommendation #1: A study should be undertaken by the City and its Harbor Department to investigate and evaluate the following factors:

a. Stability of the various bridges in the harbor area. (The City should request Caltrans to analyze the Vincent Thomas Bridge.)

b. Probability of disrupted road access.

c. Susceptibility to soil liquefaction and other earthquake-related ground failure and the resulting effects on:

(1) vehicular and boat transportation;

(2) docks, important warehouses, and essential equipment (cranes, etc.);

(3) petroleum and chemical storage tanks;

(4) pipelines carrying explosive and toxic liquids and gases;

(5) refineries and chemical processing plants.

d. Adequacy of the basins around the two large tanks of liquid petroleum gas to catch the overflow of one or both of the tanks if ruptured.

e. Fire hazard:

(1) possible causes of fire;

(2) spreading agents and containment methods;

(3) extent of possible conflagration.

f. Probability of water pipeline failure and resulting effects on fire-fighting: possible use of water from the harbor for fire-fighting.

g. Alternate means of transporting casualties and emergency equipment:

(1) by water;

(2) by air.

Recommendation #2: When the analysis outlined above is completed, develop long-range plans to respond to each potential problem.

Recommendation #3: Develop parallel contingency plans to deal with the major problems on an interim basis when an earthquake prediction is verified.

Recommendation #4: As the prediction "window" approaches, emergency supplies could be stored for personnel who cannot get home after the earthquake. Food, water, sanitation facilities, bedding, etc., may be needed.

Recommendation #5: Enlist the support of agencies and industry located in the area. Coordination of efforts among Harbor personnel, Emergency Services, oil companies, and hazardous material industries is essential.

a. The Harbor Department should determine the capabilities of cooperating agencies such as the Coast Guard, Navy, Army, Marines, State Office of Emergency Services, etc., to provide supportive aid in the event of a damaging earthquake.

b. The capabilities of industry to provide manpower and equipment for firefighting and other emergency services should be determined prior to a damaging earthquake. Contingency plans should be established that will include these capabilities, and agreements to cooperate should be confirmed.

Recommendation #6: Assuming that telephone service will not be functional, base unit radio systems should be provided to communicate with the Los Angeles Police, Fire, and Health Departments and with the Coast Guard and Navy.

Recommendation #7: Assuming that transportation routes will be blocked, prearranged command posts for the Los Angeles Police, Fire, and Health Departments should be established.

Recommendation #8: Pre-determine priorities for the repair and restoration of harbor facilities. This will save time, resources, and energy in reestablishing the Port as a viable entity.

ISSUE #7: Water Supply

The City's water supply consists of three basic components: the aqueducts and wells delivering the basic supply; tanks, dams, and reservoirs that provide storage; and the distribution system of pipelines under the City streets. The aqueducts and distribution system cross active faults in various areas. The distribution system also crosses potential landslide and soil liquefaction areas. Damage or rupture of pipelines is likely to occur whenever extensive ground movement occurs. Some of the older dams could be vulnerable to damage from an earthquake, and, even if collapse does not result, damaged reservoirs would probably be drained rapidly to prevent further problems, thus reducing the water available for emergency needs. Although wells in the San Fernando Valley and Los Angeles Basin could serve surrounding areas when reservoirs or distribution lines from outside the area are damaged, they are not routinely equipped with emergency power generators, and are likely to be out of service following an earthquake.

Recommendation #1: Review and upgrade the City's distribution system, particularly where active faults are crossed as well as in other areas susceptible to ground movement. Continue to replace and upgrade substandard and deteriorating distribution lines.

Recommendation #2: Continue to improve the versatility of the water system in terms of alternate connections and distribution lines that could be used when local damage to major distribution lines occurs.

Recommendation #3: Provide emergency power generators for a reasonable number (perhaps half of the total) of wells and pumping stations, especially for those in vital locations.

Recommendation #4: Following a long-term earthquake prediction, review and expedite the upgrading of the water system. Consider borrowing tank trucks for emergency water distribution. Educate citizens to store drinking water and to sterilize water by boiling or by solar distillation if the safety of the water is in doubt. In addition, the accessibility of alternate and stand-by water supplies could be enhanced. Emergency generators for wells and pumps should be checked, and some could be relocated closer to the potential damage areas identified by the prediction. As the time of the earthquake approaches, more operating personnel could be put on stand-by.

ISSUE #8: Dams

Older earth fill and concrete arch dams could sustain substantial damage in a major earthquake. If cracks were to occur in the earth fill dams, erosion due to leakage would tend to widen any cracks, producing further damage and possible dam collapse. The City's Department of Water and Power owns and operates many dams in the Los Angeles area as well as in Inyo and Mono Counties.

Recommendation #1: Continue to cooperate with the State Division of Safety of Dams in evaluating and upgrading existing dams, and replacing vulnerable dams where necessary.

Recommendation #2: In conformance with State law, develop an evacuation plan for potential inundation areas below dam sites. (Only 8 of 24 remain to be completed.) The State Office of Emergency Services has Flood Inundation Maps available for every dam and its downstream community. Citizens living in these areas must be informed of special precautions being taken and of procedures and suggested routes for orderly evacuation if the need arises.

Recommendation #3: Following an earthquake prediction, reservoir levels could be judiciously and selectively lowered if necessary for safety reasons.

ISSUE #9: Energy Supply

During an earthquake, electrical generation units may be damaged, blacking out parts of the City. The restoration of power service after any outage is a high-priority matter.

Recommendation #1: Existing programs to anchor and support power equipment in place should be continued and encouraged. Continuing improvement of the seismic resistance of pre-1934 masonry buildings which house power distribution equipment should be supported, and ongoing studies to improve earthquake design standards for new equipment and facilities should be encouraged.

Recommendation #2: In future City franchises, seismic safety standards and operating procedures recommended by industry or professional groups for new or existing gas and petroleum lines should be incorporated.

Recommendation #3: Agencies and industries responsible for pipelines should continue to develop emergency preparedness plans including the mapping of shut-off valve locations.

Recommendation #4: All of these measures should be expedited when a prediction is announced.

ISSUE #10: Roads and Highways

A major earthquake is likely to result in the collapse of some bridges and overpasses, local buckling of roadway segments, widespread failure of traffic control lights, and numerous accidents due to loss of vehicle control during strong ground shaking. In addition to the life hazards involved, emergency access to hard-hit areas could be jeopordized by road outages and compounded by severe traffic congestion. Good road access will be a major factor in the rate of post-earthquake recovery.

Recommendation #1: The seismic resistance of all bridges on major routes within the City should be evaluated, and a program of structural upgrading implemented.

Recommendation #2: Preceeding an earthquake prediction, mutual aid agreements should be reached between the City and County regarding the opening and closing of roads for rescue purposes and for emergency vehicles such as fire fighting equipment.

Recommendation #3: If a major prediction is received, bridge reinforcement could be accelerated, with greater emphasis on areas expected to receive higher levels of damage from the predicted earthquake. Damage prediction maps would be extremely useful for this purpose.

Recommendation #4: As the predicted time of the earthquake nears, people should be encouraged to keep road travel to a minimum in order to reduce exposure to highway hazards and to keep roads clear for emergency access. The rescheduling of work hours could be promoted to avoid rush hour congestion.

Recommendation #5: The public should be instructed on special driving procedures to be used in an earthquake, including:

a. Slow down gradually by "pumping" brakes to avoid skids and to alert following drivers. If there is severe ground shaking, anticipate that most drivers will have some difficulty controlling their cars.

b. Avoid stopping at a bridge or overpass, but pull over and come to a stop at the first reasonable opportunity.

c. Once the earthquake has subsided, check the safety of passengers and others in your vicinity, then proceed slowly, being especially alert for road damage and other hazards.

Recommendation #6: Especially hazardous road segments (vulnerable bridges, marsh crossings, etc.) may need to be closed and traffic rerouted for the duration of a prediction "time window."

ISSUE #11: Los Angeles International Airport

During an earthquake, ground lurching might wreak havoc with airport runways, causing some or all of them to be inoperable. Fortunately, the airport has a comprehensive Emergency Response Plan ready for implementation at a moment's notice. The emergencies which occur at the airport as part of routine operations require preparations similar to those necessary for an earthquake. Airport personnel are trained to cope with crowd control, damaged runways, impaired communications, power shortages, etc. If the natural gas supply were interrupted by a major shock, emergency power could be supplied for several days by stand-by generators which are operated on diesel fuel. Thus, communication and lighting facilities could remain functional.

At this writing, the airport has no plans to respond to an earthquake prediction per se. To determine what advance preparations could be taken in response to an earthquake warning, special study would be necessary.

Recommendation: Some of the measures that should be considered as possible responses to a prediction are:

a. Determine the vulnerability of runways to general lurching.

b. Inform the public of precautions and procedures for an earthquake.

c. Review and rehearse emergency procedures with all employees.

d. Advise travelers to curtail air travel as appropriate.

e. Reduce the use of elevators.

ISSUE #12: Bus and Rail Transportation

If roads and rail lines are operative and fuel is available, public transit facilities which remain functional can aid in the supply of food, equipment, and manpower to the disaster area, and an evacuation or relocation of people from the most severely damaged areas.

Recommendation #1: Establish a public transportation committee composed of representatives from the City agencies responsible for public transportation and traffic, as well as people from the transportation companies themselves.

Recommendation #2: The committee should:

a. Plan for the direction and coordination of public transit facilities following an earthquake.

b. Establish liaison with Emergency Operation Centers.

c. Inventory vehicles and equipment likely to be available in a disaster.

d. Plan to utilize trucks, taxi cabs, airlines, private airplanes and ships as necessary.

e. Study the relationship of fault systems and other earthquake hazards to transportation system facilities.

f. Identify measures that can be taken to minimize damage to transit facilities in response to a specific prediction, such as:

(1) strengthening of fixed facilities;

(2) planning for relocation of moveable facilities;

(3) planning for emergency rescheduling and reassignment of vehicles and personnel.

g. Evaluate potential power outages, fuel shortages, and the limitations they would inflict.

ISSUE #13: Communication

Normal channels of communication (telephone, electronic media, etc.) will probably be affected by a damaging earthquake. The preparation of alternate facilities is essential for reporting emergency situations, securing aid, manpower, and supplies, warning people of hazardous conditions, reassuring families who are separated, etc.

Recommendation #1: Individual households should be instructed to keep a battery-powered radio in readiness for an emergency.

Recommendation #2: Ham radio operators in local neighborhoods could serve to transmit important citizen messages to emergency operations, relatives, etc. Such local operations could be organized as part of neighborhood self-help programs in response to a prediction.

Recommendation #3: All City police and fire stations and most schools and hospitals are normally equipped with emergency two-way communications. Auxiliary (volunteer?) staffing could be trained to help man the facilities, and relay emergency messages as reported by citizens. People should know the location of their nearest emergency center.

ISSUE #14: Sewage System

Ruptured sewer lines and septic tanks could contaminate the water system through underground leakage, leading to the spread of disease. Water outages and sewer damage will prevent effective use of household toilets.

Recommendation #1: Continue to locate new sewer lines and septic tanks as far as possible from reservoirs and wells to avoid contaminating water supplies.

Recommendation #2: Following a prediction, reserve a large supply of portable toilets, and educate the people on necessary precautions in improvising temporary toilet facilities. (See Issue #7 for water purification.)

ISSUE #15: Preparing the Citizens

An informed community will be better prepared to avoid and respond to hazards in their area, and to survive with fewer hardships if lifeline services are disrupted. A well-prepared citizenry will help reduce the post-earthquake demands for emergency services and immediate aid.

Recommendation #1: A comprehensive Public Information Program should be prepared before any major prediction is received, so that it will be ready for immediate release when a warning is issued. The program should include the following components:

a. Inform citizens of the locations of gas lines and hazardous facilities in their area so they may make sensible decisions about travel routes, evacuation plans, and safety in the event of a large earthquake.

b. Distribute special instructions on when and how to turn off home and office utilities at main control points, including necessary precautions for turning them back on.

c. Recommend that all households and businesses acquire flashlights, batteries, and auxiliary cooking devices.

d. Instruct people to assemble ample sanitation supplies for garbage and waste disposal as well as personal hygiene.

e. Encourage households and offices to store drinking water and purification supplies.

(For further details, see "How To Survive An Earthquake.")

Recommendation #2: Encourage citizen evaluation of the City's earthquake and emergency operations plans to point out the needs of individuals and the ways in which they are affected by official planning. Citizen involvement in preparation of the Prediction Response Plan could be especially valuable.

Chapter 8

Public Information

BACKGROUND

Past experience has demonstrated that an immediate demand for many types of information will follow an earthquake prediction reported by the news media. The more authentic the prediction and the greater its magnitude, the more extensive the inquiries have been. In regard to personal safety, people want to know how to protect themselves, their families, homes, and work areas. In addition, they ask for the locations of faults, dams, and other hazards. Some want general information or quick answers. Others prefer extensive detail and are willing to take classes, attend meetings, or do considerable reading.

If a prediction is confirmed by the California Earthquake Prediction Evaluation Council (CEPEC) and prudent preparations are advised, questions are likely to increase. Individuals will ask what kind of assistance is available in coping with relocation, home safety, and strengthening of buildings. Businesses and financial institutions will be concerned with earthquake liability, fire and earthquake insurance, and the economic climate. Demands will be made that the City take action to solve the multitude of potential problems.

On various levels, in many functional areas, there will be a need for responsive public information, advice, and assistance. The City should be prepared to provide timely and informative answers, and to indicate clearly the areas in which assistance is available and those in which people will need to rely on themselves.

ISSUES AND RECOMMENDATIONS

ISSUE #1: Providing an Understandable Warning to the Public

If a prediction is validated by CEPEC, the State will issue an official warning, with general advice on preparation for the earthquake. The City should be prepared to supplement the general warning with advice and recommendations geared to (1) the probable effects of the predicted earthquake in the local area, and (2) the degree of earthquake safety that has been achieved in the City prior to the prediction. Warning information must be comprehensible and meaningful to the greatest possible number of people.

Recommendation #1: When a scientific prediction is issued before any action is taken by CEPEC, the Mayor could convene an Earthquake Prediction Advisory Committee to (1) assist the Mayor in formulating expectable effects of the potential earthquake for the Los Angeles area, and (2) advise in the formulation of specific warnings and local recommendations to be announced. An effective Earthquake Prediction Response Plan prepared in advance of any prediction could provide a valuable basis for selecting recommendations appropriate to the specific prediction, and would greatly enhance the efficiency and scope of the Advisory Committee's work. (See Chapter 10.)

Recommendation #2: Widespread comprehension of the local warning will be promoted by:

a. Using simple or clearly-defined terminology.

b. Transposing percentages and numerical values into intelligible phrases for additional clarity.

c. Preparing maps that incorporate familiar landmarks and verbal descriptions of important information shown.

d. Using graphic illustrations instead of complicated charts and tables whenever possible.

e. Providing the information in all major languages.

Recommendation #3: When time permits, the degree to which a warning and recommended preparations have been comprehended might be verified by sampling a cross-section of the population.

ISSUE #2: Evoking the Appropriate Response from the Public

Earthquake predictions may fail to evoke the appropriate response unless the information is understood by the recipient. A comprehensive information program is essential to communicate effectively (a) the precise meaning of a given prediction, (b) what preparedness measures to take, and (c) how to behave during and immediately after a quake occurs.

Recommendation #1: Earthquake Information Center

a. Establish an Earthquake Information Center which would become operational following a prediction. It could handle the vast majority of calls, referring only complex questions to a specific office in the appropriate department.

b. Prepare and continuously update information for the Center with the participation and cooperation of the respective departments concerned.

c. Consider having this facility function as a "rumor control center" by keeping track of common misconceptions and issuing timely press releases and informational literature to correct them.

d. Encourage the Center to facilitate a sharing of information sources and program ideas among departments.

Recommendation #2: Additional Means of Distributing Information

a. Arrange for the Mayor's field representatives and regional coordinators to circulate general information and pamphlets, channel requests for speakers, discuss proposed or current City programs, and refer people to the proper offices for more detailed information or assistance.

b. Arrange for media coverage through press releases, talk shows and interviews. If care is taken not to exaggerate the extent of danger, accurate media coverage may enhance the credibility of a specific prediction. The information should be repeated often, but in varied forms to prevent the disinterest and apathy that can be produced by monotonous repetition. Avoid immediate drop-off by reducing the frequency of announcements gradually. It is important to reach as many people as possible.

c. City employees who have regular or occasional contact with the public should carry informative pamphlets to be distributed to the citizens. These employees would not be expected to answer technical questions but simply to recommend reading the pamphlet. The text could suggest the Earthquake Information Center as a source of additional information.

d. Institute a city-wide speakers' program and suggest a teaching program for employee training officers in each pertinent department. The departments could then train and assign speakers to appear at community meetings on request. The speaker's program should make special efforts to reach the following segments of the community:

(1) Non-English speaking people

(2) Low-income groups

(3) Labor groups

(4) The handicapped

(5) The elderly

e. Investigate the use of videotape training materials like those employed by the Police Department. Perhaps a videotape prepared for teaching purposes could be made available to all departments.

f. Utilize outside organizations to provide additional public information programs. Organizations that might offer this service are:

Insurance Companies
Home Lending Institutions
Labor Organizations
Women's Service Organizations
(American Legion Auxiliary)
City Schools (grades 3-12,
Adult Education)
Red Cross Survival Training Programs
Utility Companies
Colleges and Universities
(faculty speakers, extension
courses)

ISSUE #3: Informing Public Officials

Public officials need to be informed regularly on (1) public reactions to the prediction, and (2) the effectiveness of their statements in meeting the needs of the community.

Recommendation: During the prediction period, monitor public opinion through feedback from community groups and knowledgeable, concerned individuals. Keep the City Council, Department heads, and other city officials informed on the results of the monitoring.

ISSUE #4: Selecting and Educating Community Opinion Leaders

Unless the support of community opinion leaders is attained, it is possible that a valid earthquake prediction will have a less-than-desired effect. The prediction, with subsequent warning and recommendations, might even be undermined by well-intentioned but misinformed community leaders.

Recommendation #1: Leader Identification

Survey the various major population groups in Los Angeles to identify the opinion leaders whose ideas on earthquake prediction would be most influential. These opinion leaders may be in local government, the mass media, or perhaps the scientific community. At the community level, the opinion leaders may be heads of any of the various civic or religious organizations.

Recommendation #2: Leader Education

Once identified, leaders should be informed of the problems associated with earthquake prediction. The specific methods of education may involve seminars, individual contact, and conferences. Leader education programs should be developed as soon as possible, and carried out when the appropriate leaders are identified. The ground work for this program should be part of an Earthquake Prediction Response Plan.

ISSUE #5: Utilizing City Agencies

Many City agencies can contribute productively to public information efforts.

Recommendations:

1. General: Instruct various City departments to assemble earthquake safety informational materials in preparation for a prediction. Each office should be prepared to conduct special educational programs on short notice. A designated Earthquake Information Officer should have immediate access to training materials, videotapes, and slides. He should also plan a coordinated program using specified department personnel. The advance training of various employees to present occasional talks or programs on earthquakes would provide an immediate talent pool following a prediction.

2. City Library: Could post and distribute pamphlets and supply each branch with relevant literature, such as Scientific American and National Geographic articles on earthquake prediction, books and brochures on earthquake safety and survival (e.g., Peace of Mind in Earthquake Country).

Could sponsor local programs of group research, book reports, films, etc., on earthquakes.

Can provide maps and report on the locations and nature of earthquake hazards in the City.

3. Department of Recreation and Parks: Could sponsor survival, first aid, and self-help classes. Could present films and other educational programs on understanding earthquakes and earthquake safety.

4. Department of Building and Safety: Can distribute widely their pamphlet, "Earthquakes--Safety and Survival." Can provide a brochure on the protection of vacant buildings. Can expand their speakers' program on earthquake safety. Could offer to both owners and tenants an efficient call-in service that would identify potentially hazardous buildings, suggest general corrections or precautions, and recommend contacts for further specifics, such as engineering valuations.

5. Fire Department: Could distribute pamphlets such as "Earthquakes--Safety and Survival," and expand speakers' program to cover a wide range of earthquake safety concerns. Could inform public of emergency communications system that would be available to them after a disaster.

6. Police Department: Can provide pamphlets and speakers' programs, as described above, with an emphasis on protecting vacant buildings and preventing looting after an earthquake. Can inform public of emergency communications systems. Can educate public on procedures for possible evacuation and return to evacuated area.

7. Department of Water and Power: Can prepare a factual program on dam location, potential inundation areas, precautions they may have taken in lowering water levels and upgrading dams, etc. Can prepare information on (1) detection of unsafe drinking water and sterilization procedures, (2) safety precautions with electrical appliances, wiring, power poles, etc. Can distribute earthquake safety pamphlets, include brochures with bi-monthly bills, and provide speakers on general earthquake safety.

8. Director of Housing and Housing Agencies: Can supply special information on (1) safety of housing; (2) relocation from unsafe housing; (3) loans or grants for emergency reinforcement, demolition or relocation; and (4) safety precautions for the interior of a building (furniture, bookcases, windows, light fixtures, gas appliances, circuit breakers, etc.). Should work with other departments to develop a pamphlet: "Is Your House Safe in an Earthquake?". The Community Development Agency can refer problems to the appropriate federal or state agency.

9. Planning Department: Can provide pamphlets on earthquake safety at community meetings. Consider setting up the Prediction Information Center in conjunction with their new information facility.

10. Special Program Offices (Senior Citizens, Handicapped, etc.): Can prepare specialized information and procedures for their constituents and arrange for distribution of this material by mail, phone, or speakers' programs.

11. City Council Members: Can send letters to their constituents outlining safety precautions individuals can take and explaining programs and precautions the City has instituted. Can mail or distribute brochures on earthquake safety; can provide their own speakers or can refer citizens to appropriate offices for more specific information.

ISSUE #6: Discouraging Opportunists

At times of crisis and social disorientation, some individuals "prey" on the insecurities of unwary members of a community. Following a credible prediction, the public must beware of unscrupulous real estate salespersons, unqualified consultants, and contractors who offer inadequate construction repair.

Recommendation: The Mayor could stress publicly the threat of these opportunists, and encourage the media and professional societies to expose any such activity. The State Department of Consumer Affairs could be requested to investigate specific cases.

Chapter 9

Emergency Prepardedness

BACKGROUND

The existing Civil Defense and Disaster Ordinance grants to the Mayor, as head of Civil Defense, the power to invoke emergency procedures. It assigns responsibility to the City departments that will be called in for immediate service, and defines the functions of those departments. Ordering them to suspend normal activities and begin emergency procedures, it allows them to cut through red tape, eliminate cost comparison, to take virtually any steps necessary to expedite their work.

A new Operational Earthquake Response Plan has been drawn up by a Joint Earthquake Planning Committee. Both this plan and the Disaster Ordinance pertain to emergency measures in the case of an actual earthquake.

No plans are currently available for activities that would be needed in response to the prediction of an earthquake. Such plans should include procedures for enhanced readiness, special measures geared to the specific timing, location, and magnitude of the predicted earthquake, and a public information program.

Implementation of an Earthquake Prediction Response Plan would commence when a scientific prediction is validated by the California Earthquake Prediction Evaluation Council (CEPEC), whereas the Earthquake Response Plan would go into effect when an earthquake actually occurs. Integration of the prediction and emergency response plans is essential to avoid duplication, to coordinate efforts, and to maximize efficiency.

The basic objective of earthquake prediction response planning is to establish, prior to the onset of an emergency situation, a framework of authority and a basis for action that will take into account both the socioeconomic advantages and disadvantages of a scientifically based earthquake prediction.

ISSUES AND RECOMMENDATIONS

ISSUE #1: Determining Appropriate Prediction Responses

The development of an appropriate response to an earthquake prediction will require some hard decisions involving various levels of social and economic disruption. Such decisions will require sound technical advice, but will be basically political and will require broad support.

Recommendation: An Earthquake Prediction Advisory Committee should advise the Mayor and the Civil Defense and Disaster Board on the significance of specific predictions to Los Angeles and help determine appropriate levels of response to each prediction received. (See Chapter 5, Issue #2.) The Advisory Committee should also assist in the preparation of the City's Earthquake Prediction Response Plan.

ISSUE #2: Developing a Response Plan

Any meaningful response to an earthquake prediction will result in some level of disruption. Generally, the greater the response to prevent potential loss of life and property, the greater the disruption. Therefore, plans must include various levels of response for varying degrees of confidence that a damaging event will occur.

Recommendation #1: The Civil Defense and Disaster Board should participate in the development of a multi-level earthquake prediction response plan.

Recommendation #2: City staff under the appropriate office should be expanded with the necessary personnel and logistical support to coordinate the development of a response plan.

Recommendation #3: In developing an earthquake prediction response plan, consider the following suggestions:

a. Establish priorities and policy for the long-term situation.

b. Plan for minimum to maximum response levels taking into account the socioeconomic repercussions of various courses of action.

c. Review, update, or develop when necessary:

(1) Maps indicating potential high-risk areas (fire, dam collapse, landslide, hazardous structures, etc.)

(2) Procedures for anticipating distribution of damage and ensuing hazards (e.g., damage maps).

(3) Preparedness plans and post-earthquake capabilities of organizations and institutions operating lifeline systems (hospital, power, natural gas, sanitation, communications, transportation facilities).

(4) Staffing, operation, and communications capabilities of the Emergency Operating Center (EOC) and other headquarters.

(5) Mutual aid agreements.

(6) Means for informing the public.

(7) Emergency service organizations and their responsibilities.

(8) Legislation and local ordinances.

d. When a prediction is issued, initiate separate workshops for each emergency organization in which they review their respective post-earthquake actions. Although many of the following tasks are in process or already have been completed in general terms, they will need to be examined in closer detail when the specific characteristics of a particular prediction (e.g., time, location, magnitude, and anticipated damage) are known.

(1) Assign responsibility to service units and personnel for specific actions indicating precisely when, where, how, and with what resources actions are to be accomplished.

(2) Evaluate existing capability for performing the specified actions and, where appropriate, identify measures and resources to improve capability.

(3) Identify measures that will reduce earthquake losses, e.g., moving equipment to safer locations.

(4) Determine activities and services that could be deferred or curtailed, freeing funds for emergency preparations.

(5) Develop plans to be implemented when a short-term warning is issued, e.g., evacuation.

(6) Determine requirements and prepare procurement orders for needed equipment and supplies.

Recommendation #4: The following plans of action suggested by the State Office of Emergency Services should be evaluated and augmented for inclusion in any prediction response plan.

a. Consider actions to reduce risk of hazardous structures and locations, e.g., removal, strengthening, prohibition of occupancy.

b. Expand fire prevention programs and abatement of fire hazards to meet the specific problems of a predicted earthquake.

(1) Augment firefighting resources; prepare mobilization instructions.

(2) Survey community for high-risk fire areas, modifying or confirming fire contingency plans as appropriate.

c. Improve the capability of emergency service organizations.

(1) Recruit, train, and assign personnel as needed.

(2) Review mobilization instructions.

(3) Bring the EOC and other headquarters to full readiness; provide auxiliary power, and augment communications.

(4) Arrange for, and prepare for use, facilities selected for staging areas, mass care centers, etc.

(5) Procure necessary equipment and supplies.

d. Improve readiness in potential dam and tsunami flood areas.

(1) Check on evacuation plans, warning systems.

(2) Arrange for transfer of key facilities.

(3) Establish engineering procedures to determine potential extent of damage.

(4) Consider other methods to alleviate emergency (e.g., lowering water level).

e. Improve readiness and capability of lifeline systems, resource agencies, and essential industries.

(1) Identify measures to reduce earthquake losses and disruption of services.

(2) Activate standby agreements for lifelines systems.

(3) Consider relocation of resources to areas outside the high-risk area.

(4) Prepare instructions for mobilizing medical personnel and resources.

(a) Expand stocks of drugs, medicines, and sanitation supplies.

(b) Check readiness of hospitals to discharge or move patients and expand bed capacity; suggest deferring elective surgery.

f. Brief key government officials and private sector leaders on planned responses, as prescribed.

ISSUE #3: Preparing City Hall

Recommendation: Instruct the General Manager of each City department to develop and implement an earthquake awareness program within his respective department. Such programs should consider the impact of an earthquake prediction upon the work environment of management and operational personnel. Contingency plans should be developed within each department for maximum efficiency in implementing appropriate responses and preparing for the anticipated quake.

ISSUE #4: Preparing the Citizens

In a disaster the size of an earthquake, emergency assistance will be concentrated in the areas of greatest damage. Less severely hit areas will be isolated, with little or no outside aid for a period of several hours to several days. Because of the likely complications of street hazards, limited access, and traffic congestion, people should be discouraged from driving.

Recommendation #1: Encourage "self-help" programs based in the family, the neighborhood, or the local community. Through these programs, people could begin to deal with the most acute problems until outside services (fire, medical, housing, food) become available.

Recommendation #2: A "neighborhood self-help" kit should be prepared to provide information for a neighborhood or family to prepare and coordinate appropriate supplies, special training, and contingency plans to help them best survive the immediate aftermath of an earthquake.

Recommendation #3: Police, Fire Department, and other City-sponsored public education sessions should be supplemented to provide special advice and assistance to neighborhood and community groups who want to set up their own "self-help" programs. Through meetings and phone response, advice can be tailored to the specific environment and capabilities of each group. "Self-help" kits could be demonstrated and distributed at public education programs. (See also Chapter 8.)

Recommendation #4: To eliminate the need for driving, urge people to seek help within their immediate neighborhood, preferably from pre-arranged centers within walking distance.

Chapter 10

Earthquake Prediction Response Plan

We now realize that the credible prediction of a major earthquake could set in motion a series of economic and social changes and a demand for information and action to which we are not yet prepared to respond. Without an organized and well thought-out plan of response, the opportunity to save lives and property, to reassure and prepare citizens, to safeguard essential facilities and to maintain a viable local economy would probably be lost. The Task Force considers the best coordinating and planning mechanism for prediction preparations to be an Earthquake Prediction Response Plan. Many topics and recommendations for incorporation in the plan are included in the preceding chapters. This section deals with some general issues and overall organization pertinent to the preparation of a Response Plan.

TIME FRAME AND LEVEL OF RESPONSE

A highly versatile response plan is needed if the City is to be prepared to deal with the many variables that would comprise a specific prediction. The magnitude, lead time, location, and probability (confidence level) would each play a role in the selection of an appropriate plan of action. For instance, a three-year lead time would allow the upgrading of hazardous structures, whereas a three-day prediction may call for selective evacuation of hazardous buildings.

Magnitude and Location

The two variables of magnitude and location can be combined into one parameter -- estimated intensity, which would indicate the general degree of shaking and ground movement that is likely to be experienced in Los Angeles during the predicted earthquake. This would help distinguish, for example, between a response to a Magnitude 6 predicted for the San Bernardino area, and a Magnitude 6 in the San Pedro area. It would also allow different levels of response, as appropriate, for different parts of the City, thereby focusing efforts in areas of greatest need. At a basic level, intensity would be determined by both the magnitude of the predicted earthquake and the relative distance from the predicted location. At a higher level of refinement, the designation of anticipated intensity could incorporate areas inherently more susceptible to earthquake damage: locations of expected fault movement or potential landslide reactivation, soil liquefaction-prone areas, and locations of "soft" ground, such as young valley deposits. Modified Mercalli intensities need not be assigned in either case, but more general designations of "low, moderate, high and very high," relating to expectable damage levels, could be used.

Probability or Confidence Level

As they do in weather and hurricane predictions, scientists recognize the need to assign a probability that the predicted earthquake will occur. Unfortunately, probability estimates require some statistical basis of experience, and the sparcity of existing data on monitored earthquakes does not yet allow statistical treatment. In the meantime, a scientist instead may assign a "confidence level", related to (1) his/her estimation of the reliability of the prediction model being applied, and (2) how well the data fits the model.

Response Level

The confidence level or probability can be combined with intensity in a simple graph outlining an appropriate level of response (Figure 1). The greater the intensity and the higher the confidence level, the higher the level of response that would be indicated. In this example, four levels of response are possible. General descriptions appropriate to each level are as follows:

Minimal response - Where a low intensity or low confidence level is assigned, the threat of the predicted earthquake should not be reinforced, but the Mayor and the City could respond to any public concern by providing information and explaining programs that will better prepare the community for any earthquake. This level of response would also be appropriate where a prediction is not verified by CEPEC, but continues to generate public concern.

Limited response - Where the perceived threat is at a moderate level, a limited response could intensify City earthquake safety programs, encourage similar actions in the private sector, and provide a broad-based public information program to better prepare the citizens and prevent unnecessary economic strain and social apprehension. Aside from selective acceleration of existing earthquake abatement programs as time permits, the only mandatory responses would be at governmental levels; most or all preparations in the private sector would be voluntary.

Moderate response - Some mandatory programs in the private sector could be added in cases where potential savings in life and property are considerable; government response should be thorough and deliberate; a wider range of voluntary efforts could be encouraged; economic reactions should be monitored and counteracted where appropriate.

Full response - Where the threat of a destructive earthquake is very real, more extreme measures should be considered, such as: evacuation of selected buildings or areas; compulsory inspection and upgrading of all petroleum storage facilities; closing of selected bridges and overpasses; enactment of new building codes to correct problems related to structural ties and mechanical equipment in existing buildings; undertaking a highly-coordinated and intensive citizen preparedness program; seeking Federal disaster assistance; and initiating specific programs to counteract non-productive economic reactions.

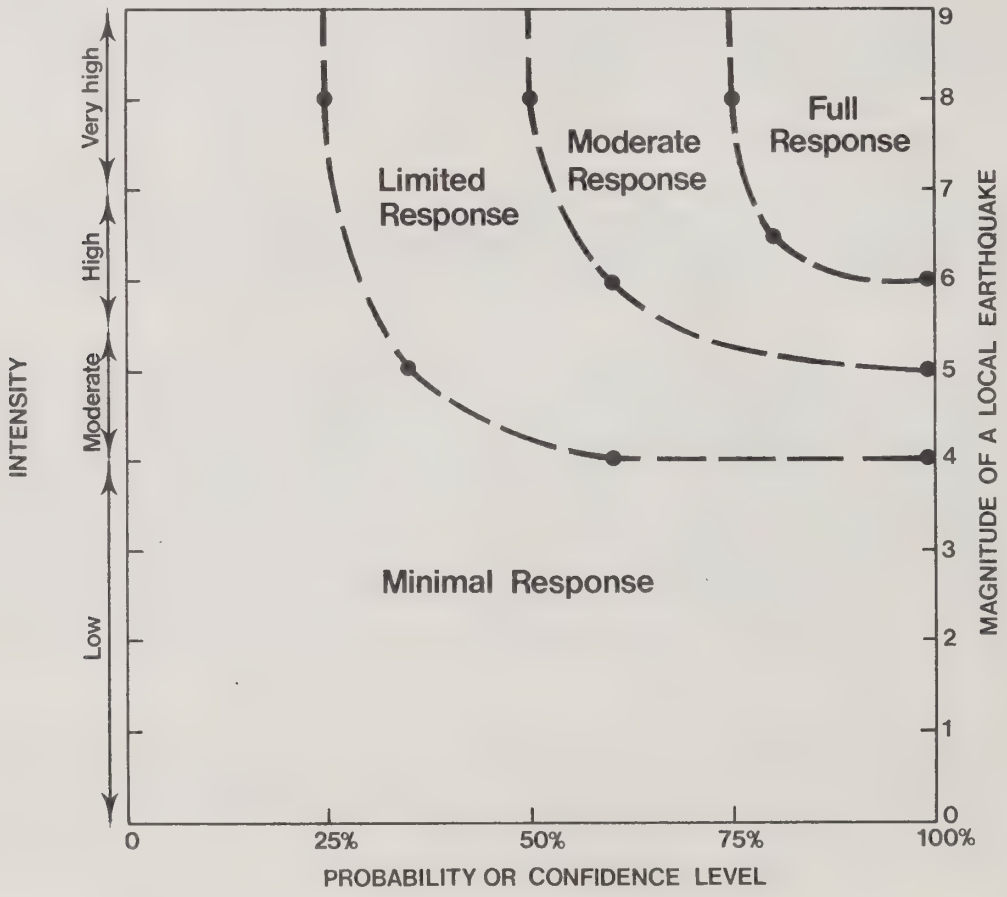

Figure 1. Suggested format for determing an appropriate response level for a specific prediction.

Time Frame

Once a response level is selected, the specific components of the response should be geared to the lead time available before the predicted event. A simple chart (Figure 2) illustrates the range of appropriate actions. Plans for each time frame should be available in advance of a prediction, so that they can be implemented in a responsive and timely fashion. Where City Council action is required, appropriate authority should be obtained, or conceptual groundwork laid in advance so that the long process of initiation and debate can be expedited if necessary.

An outline of actions appropriate for each time frame will be needed for each area of concern -- utilities, lifelines, buildings, public information, economic stability, etc. -- as each topic will require different solutions. As the time of a predicted earthquake nears, the operating response may need to shift from longer-term activities to shorter-term activities selected from the next time frame.

RESPONSE LEVEL	LEAD TIME		
	Long (years)	Intermediate (months to 1.5 yrs.)	Short (days)
Minimal	Public education and information programs as appropriate.		
Limited	Initiate and accelerate selected seismic safety measures within City Government.	Accelerate or modify selected features of existing City programs, inspect City facilities, encourage private actions.	Emergency crews on alert, prepare and educate citizens and employees, close hazardous public buildings.
Moderate	Initiate and acclerate selected codes for upgrading of private and public facilities.	Acclerate codes for upgrading, provide relocation assistance, inspect critical facilities.	Adjust work and vacation schedules, close or evacuate selected facilities.
Full	Enact codes for mandatory upgrading of hazardous facilities.	Acclerate codes for upgrading, initiate mandatory relocation programs.	Intensive education, selected evacuation, emergency crews on duty, close vulnerable bridges and overpasses.

Figure 2. Range of appropriate actions with varying response levels and lead times (simplified example.)

GENERAL STRUCTURE OF A RESPONSE PLAN

A key component of any Earthquake Prediction Response Plan will be the organizational framework for producing, updating and carrying out the plan. Because of the wide variety of topics that need to be dealt with (economics, social and psychological stability, broad-based public information programs), the group preparing the plan will need to include resources beyond the traditional make-up of the Civil Defense and Disaster Board. It is recommended that business and community leaders, utility representatives, sociologists, geologists, seismologists, engineers and architects participate actively in the preparation of the response plan. Special material for the handicapped, the elderly and foreign-speaking people will need to be developed, and agencies familiar with these constituencies should be invited or recruited to participate. Several scientists in social, engineering, economic and governmental fields have conducted years of research in the areas related to earthquake prediction; they would probably be very willing to share their insights and participate in formulating various components of the plan. The Civil Defense and Disaster Board would also have an important role in preparing a response plan, as many of the components of the plan would come under its authority for implementation.

The response plan itself will need to establish a structure for 1) evaluating the local significance of any specific prediction, 2) determining the appropriate response, and 3) expeditiously carrying out the various aspects of the chosen response. It will also need to identify ongoing goals that would make the plan more effective, and to provide a mechanism for periodic review and updating of the plan as new programs, options and legal authority become available. Some basic suggestions[3] for accomplishing these objectives are outlined below.

Earthquake Prediction Advisory Committee

Outside resource people will probably be needed to help evaluate the significance of a specific prediction for the local area. A committee composed of seismologist, geologist, structural engineer, legal and business members should be established to advise the Mayor and other personnel on the significance of each prediction and the types of response that would be appropriate. The committee could meet immediately following the announcement of any relevant prediction (presumably prior to any finding of CEPEC) and provide an initial, informal assessment on an interim basis. This would 1) help prepare the Mayor and other staff members to respond to initial press and citizen inquiries, and 2) prompt the initiation of any special preparations that may be advisable in anticipation of a possible confirmation of the prediction by CEPEC. If the prediction were not confirmed by CEPEC, no additional meetings may be necessary for that prediction, and a minimal response could be initiated as per the response plan. If the prediction were validated by CEPEC, the Advisory Committee would be assembled again to perform several tasks: 1) clarify the meaning of the various components of the prediction (time, location, confidence level, etc.), 2) provide a preliminary estimate of the intensity that would be experienced within the City, 3) help select the appropriate response level, and 4) generally clarify any potential misconceptions of what the prediction does and does not mean. The committee could also provide advice on the appropriate mechanism and methodology for producing more specific intensity estimates and damage maps within the time frame presented by the prediction. After this initial effort, the committee or individual members could be reconvened as needed to provide further assistance to the Mayor or to specific City boards and agencies. The committee would not necessarily be responsible for specifying the full slate of appropriate responses for the predicted earthquake, nor would they be directly involved in implementing the selected response. However, they might help monitor the effectiveness of the chosen response and suggest adjustments as warranted.

"Prediction Response Board"

An operating group of City and public representatives will be needed to select a specific program of action at the general response level warranted by the prediction. All major operating departments of the City should be represented, as well as business, utilities and community leaders. The individuals responsible for an earthquake prediction information center could be valuable members of this group. The "response board" would also coordinate and oversee all major components of a response effort, including governmental coordination at the local, State and Federal levels. As an alternative, a "Prediction Response Coordinator" could be assigned full-time to assist and coordinate the many components, and actual convening of the Board could be kept to a minimum.

Program Development, Legislative Action, Research and Update

During the preparation of the Prediction Response Plan, programs will need to be developed for such aspects as the centralized Earthquake Prediction Information Center, a broad-based public education and "self-help" program, the monitoring of economic repercussions, and achieving the cooperation and consensus of other jurisdictions. Legal questions can be further investigated, and appropriate legislation should be sought. Special working groups could help establish programs for correcting structural hazards and safeguarding lifeline facilities, as suggested in earlier chapters, and various areas of research could be sponsored or encouraged.

By the time the first Earthquake Prediction Response Plan is prepared, several of the major questions posed in earlier chapters may be answered, but others will still stand. The Response Plan should therefore include goals for resolving the remaining problems, so that those objectives can be addressed in ongoing City efforts. The Response Plan should then be reviewed at predetermined intervals of a year or two, and the results of the ongoing research, legislation, and program development activities should be reflected in appropriate revisions to the plan.

Glossary

Damaging Earthquake	An earthquake of Richter magnitude 5.5 or greater.
Fault	A zone of weakness in the earth's crust where movement between two crustal blocks has taken place.
Intensity	The strength of an earthquake as felt at any given location, expressed in terms of the Modified Mercalli scale.
Lead Time	The time between receipt of the prediction and the anticipated date of the earthquake.
Lead Time Horizons	Short term - up to one month. Intermediate term - one month to one year. Long term - one or more years.
Liquefaction	The sudden and temporary transformation of loose, water-saturated soil to a liquid mass when subjected to shock or strain.
Magnitude	The energy released by an earthquake at its focus, as measured on the Richter Scale.
Prediction	A statement of the time, magnitude and location of an impending earthquake. An indication of confidence level or probability of the predicted event is also desirable.
Seiche	A standing wave oscillation on the surface of a lake or semi-enclosed body of water.
Surge Wave	A spreading wave generated by landslide, soil failure, seiche, explosion or falling material.
Time Frame	The length of time available before a predicted earthquake. (See Lead Time Horizons.)
Time Window	The period of time during which the predicted earthquake is expected to occur.
Tsunami	Seismic sea waves of long wave length, generated by some earthquakes and underwater landslides.
Unreinforced Masonry	Stonework or brickwork lacking the supplemental steel reinforcing bars which help tie the masonry together and add vertical support for overlying parts of the structure.
Warning	An official recommendation that normal life routines should be altered for a time to deal with an impending danger. It identifies a situation as dangerous and advises its recipients that the risk to life and property can be reduced by an appropriate response.

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PREDICTION RESPONSE • LIFELINE SAFE
LEAD TIME • UPGRADE • PREPARATIO
TARGET AREA • DAMAGE MAPS • WARNI
SOCIAL IMPACT • BUILDING SAFETY • SE
HELP GROUPS • LEGAL ISSUES • NATIONA
HAZARD INSURANCE • SEISMIC STANDAR
EMERGENCY PREPAREDNESS • RESPONS
LEVEL • UNEMPLOYMENT • GOVERNME
COORDINATION • PUBLIC INFORMATI
STATE OF EMERGENCY • MERCALLI SCA
PYSCHOLOGICAL EFFECTS • RELOCATI
INTENSITY • SURGE WAVES • TSUNA
DISASTER AREA • FAULT • RICHTER SCA
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